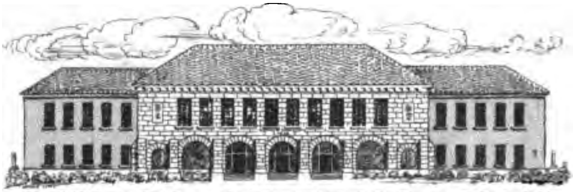
APPLIED PHYSIOLOGY

INTERMEDIATE

BY
FRANK OVERTON M.D.



APPLIED PHYSIOLOGY

INCLUDING

THE EFFECTS OF ALCOHOL AND NARCOTICS

BY

FRANK OVERTON, A.M., M.D.

LATE HOUSE SURGEON TO THE CITY HOSPITAL, NEW YORK

INTERMEDIATE GRADE

NEW YORK ·:· CINCINNATI ·:· CHICAGO
AMERICAN BOOK COMPANY

PREFACE

THE author of this intermediate grade of *Applied Physiology* has designed the work to be not merely an introduction to the study of anatomy and physiology, but a complete elementary work in itself, giving a clear picture of how each organ of the body performs its work.

In presenting hygienic facts to pupils before they have an elementary knowledge of anatomy and physiology, there is a violation of pedagogical principles. The laws of healthful living cannot be grasped without this elementary knowledge of the human machine to which the laws apply. Advice to a pupil will have an effect in direct proportion to the confidence reposed in the teacher. New environments and duties demand new applications of laws. Every business man is often compelled to break common hygienic laws in regard to eating, exposure, and overwork. Thus mere advising conduces but little toward intelligent living. On the other hand, prohibition arouses in children a desire to do the forbidden thing, especially if it be a rule insisted upon at school. Moreover, the unavoidable inconsistencies of teachers themselves will upset the pupil's confidence in all laws. For these reasons dogmatic hygienic advice is avoided, but anatomical and physiological facts are simply stated and developed.

By way of example, however, it has seemed wise to indicate detailed hygienic applications of physiology and anatomy along a single line, leaving it to teachers to apply the same principles to other abuses of the body in answer to

the numerous questions which every class will undoubtedly ask. For this purpose the subject of alcohol and tobacco has been selected, both because of their wide-spread abuse, and also because of their universal effect upon all parts of the body. In this way the pupil will be made to realize the wide-spread results of abusing even a single part of the body. Great care has been exercised to make the discussion of stimulants and narcotics correct in every particular, and to bring it fully into conformity with the most recent temperance legislation.

The cuts are mostly selected from the author's advanced work, but a few original ones have been added. The microscopic appearances of tissues have been especially emphasized.

Practical demonstrations have been omitted; for, without explanations, they are meaningless to pupils of the intermediate grades. Yet, without demonstrations the intelligent study of unfamiliar parts is impossible. Teachers will find an outline of a complete, yet simple, series of experiments in the author's advanced work.

With the desire to supply a long-felt want, the author presents these results of experience and thought to teachers and pupils.

PATCHOGUE, N.Y.

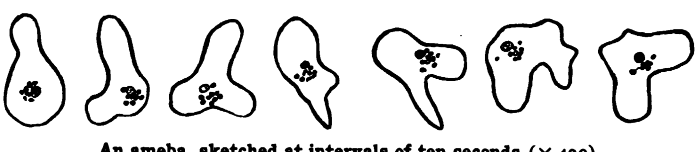
CONTENTS

APPLIED PHYSIOLOGY

CHAPTER I

CELLS

1. The ameba. — In moist earth there lives a little animal called the *ameba*. It is so small that you cannot see it without a magnifying glass many times as strong as the best spectacles. When you do see it you will not know that it is an animal, for it has neither eyes, nor head, nor arms, nor legs. It is simply like a lump of jelly. But if you look a minute, you will see it put forth some part of its body like a finger to take a little lump of food. This finger is also a mouth and swallows the food. Then the

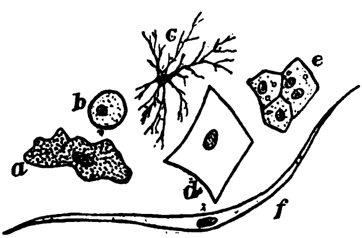


An ameba, sketched at intervals of ten seconds (× 400).

finger becomes a stomach and changes the food to blood so that the animal can grow. When it wants to go for a walk, it puts forth a finger, and then the whole body rolls itself into the finger, and thus it moves forward. So the little ameba can make an arm, or a mouth, or a stomach, or a leg, wherever and whenever it wants to.

An animal that can make any part of its body anew to suit itself should be very prosperous and happy. In fact, the ameba does grow so fast that in a day or two it thinks itself big enough to become two animals, and so it splits itself into two parts, and each half goes off by itself as a full-grown ameba.

2. Cells. — Man has a separate part of the body set aside to do each kind of work. He has legs which carry him to his food, and arms with which to get the food, and a mouth with which to eat it. But these parts do not make the real man, for some men lose their arms and legs and yet remain men. The real man is the mind which lives in the body and makes the arms, and legs, and mouth do as it wants them to do. But a man's arm or his leg, or any other part of his body, is itself made of millions of little living things like the ameba. We call each of these living things a *cell*. Some of these cells are long, some flat, and some of other shapes. Each has the form best fitted for the work it does, but all are exceedingly small. They are held in place by fine strings called *connective tissue*. By scraping the skin, cells can be removed from its surface. They look like flour.



Cells from the human body (× 200).

a A colored cell from the eye.
b A white blood cell.
c A connective tissue cell.
d A cell from the lining of the mouth.
e Liver cells.
f A muscle cell from the intestine.

3. Mind rules the cells. — The mind takes good care of these cells. When we eat we feed the cells, and we breathe so that each cell can get a little air. To repay the mind for its care the cells all work together like good ser-

vants to do just as the mind tells them. Thus, when the mind wants to walk, all the cells of the legs get themselves under the body and push the body ahead. They do it so willingly that we do not think how hard they have to work. When the mind wishes to stop, it tells the cells of the legs that they need not work any more until it wishes to move again.

Sometimes it is very hard for the mind to teach the cells to work just as they should and to keep still when they ought. Boys and girls go to school so that they may learn how to make the cells obey the mind. We ought to take

Water, 12 gallons. Sugar, ¼ lb. Ashes, 12 lb. Albumin or gelatine, 20 lb. Fat, 10 lb.

Substances of which the body is composed.

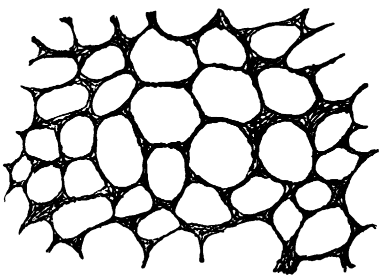
good care of our bodies because the living cells of which they are composed make such good servants for the mind.

4. **Of what the cells are made: water.** — About three fourths of each cell of the body is *water*. Water is found even in teeth and in bone. All animals must have water to drink. Even the driest food, like crackers, has a great deal of water, while other kinds, like meat and potatoes, are nearly three fourths water. In all, a man swallows two or three quarts of water each day.

5. **Albumin.** — Next to water something which is like

the white of an egg forms the most of the body. This substance is called *albumin*, because when boiled it becomes white and hard. It is the living part of cells and must be eaten to sustain their life. It is found in all food, both animal and vegetable. We eat about four and a half ounces of albumin each day.

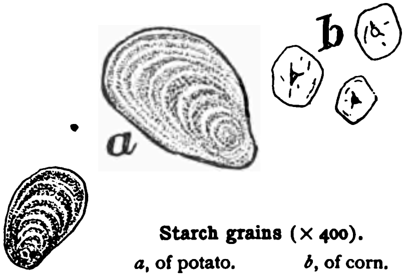
6. Fat. — *Oil*, or *fat*, is found in little pockets between the cells. It is in a liquid form, and becomes hard only when the body cools after death. When we boil a piece of meat, the pockets are softened so that the fat runs out and floats upon the top of the water. Fat must be eaten in order that the cells of the body may be healthy, but they can live for a long time without it, for the fat of the body is made out of albumin, and not from the fat which is eaten. The fat around the cells is like a cushion which protects the cells and keeps them warm. It also makes the body round and handsome. Fat is found in all common food. We eat about three ounces each day.



Fat tissue ($\times$ 100).
Connective tissue cells form pockets in which the liquid fat is stored.

7. Starch and sugar. — *Starch* and *sugar* also enter the body as food. Only a little of these is really found in the body at once, for it is soon used up in warming the body. Starch is found in all vegetable food in the form of small grains. Cooking in hot water makes these grains swell and burst. Then they dissolve in water and form a paste. In the young plant there is but little sugar and a great deal of starch, but when the plant ripens, the

starch changes to sugar. When starch is eaten, it is also changed to sugar. So starch and sugar are the same kind of food. About one quarter of a pound of starch or sugar must be eaten each day.



Starch grains (× 400).
a, of potato. *b*, of corn.

8. **Minerals.** — In the body there are also *minerals*, such as lime, iron, potash, and salt. When the body is burned, these are left behind as *ashes*. The lime stiffens the bones. Iron is found in the blood and coloring matter of the body. Potash and salt are found all through the body. These minerals are found in all food, for all leave ashes when burned. Yet some salt must be added to food.

9. **Food.** — Everything which makes the cells and fluids of the body is composed of either water, albumin, fat, sugar, or minerals. These sustain life, and are *foods*. All other kinds of substances are harmful or poisonous.

10. **Oxidation.** — All kinds of food are constantly being eaten, and yet only water and mineral substances leave the body in anything like the form in which they entered. What becomes of the rest?

When a piece of meat is put into a hot fire, it bursts into a flame and burns to smoke and ashes. By its burning it gives off heat, and makes the fire hotter. If the draft of the stove is closed tightly, the fire does not burn, for a stream of air must flow steadily into the fire. The air is one fifth oxygen gas. This oxygen unites with the meat and forms two invisible gases — *carbonic acid gas* and *vapor of water*. These gases are the smoke. The

ashes are the mineral parts of the meat. This is what takes place in every fire. We call it *oxidation.* If the fire is under the boiler of an engine, the heat is used in changing the water to steam. The steam can then be made to do work.

11. Oxidation within the body. — Besides meat and other kinds of food, air is also taken inside of our bodies. Carbonic acid gas and water are given off in the breath, our bodies are warmed, and they perform work, as a steam engine does. The body is really an engine directed by the mind. The lungs are the boilers, while the nose is the draft where the oxygen enters and the carbonic acid gas and water pass out. Both the food and the cells of the body are oxidized. By the oxidation the same heat is produced as though the food were burned outside the body, but it occurs so slowly that no flame is produced. Most of the heat simply warms the body. The muscles and brain form the engine which changes the rest of the heat to work. All the power of a man's body is derived from the heat of oxidation. Running, speaking, and thinking are different kinds of work, and depend upon the heat of oxidation for power.

Diagram of burning or oxidation in a stove.

12. Use of food. — The greater part of the fuel for oxidation is supplied by the food before it reaches the cells of the body. The cells themselves are also slowly oxidized. In course of time their substance is completely burned up,

and its place supplied by new food. So the object in taking food is both to supply the cells with what was burned from them, and also to furnish fuel for the greater part of the oxidation within the body.

Water and mineral substances are not oxidized, but only add weight to the cells of the body. Fat and starch give only heat. Albumin gives both weight and heat, for it both becomes a part of the living cells and also is oxidized. So anything which gives either weight or heat to the body is *food.*

Diagram of the restoration of oxygen to the air after oxidation, and of the rebuilding of burned material into living forms.

13. Relation of plants to animals. — Man's food comes both from animals and from vegetables, but animals feed upon vegetables, or else eat other animals which eat vegetables. Vegetables feed upon substances in the soil and air. The burned-up parts of man and animals go back to the soil and air and become food for plants. Thus plants build the burned products of man's body into food, which can be used once more by man. So year after year the food makes the round from the soil to the plants, and then to animals and man, and back again to the soil. A plant lives on the soil and air. An animal cannot live on these, but must eat what plants have formed from them. This makes the real difference between plants and animals.

SUMMARY

1. The body is made of separate living cells, each like a little animal.
2. Each cell obeys the mind and works for the benefit of the body.
3. Cells are made of five things; viz., water, albumin, fat, starch, or sugar, and mineral substances.
4. These five substances are formed outside the body, and are food for man.
5. Oxygen is also taken inside the body, and burns up or oxidizes the food and some of the substances of the cells.
6. By the oxidation within the body heat is produced.
7. The cells of the body form an engine which changes some of the heat to work.
8. What we eat either is added to the cells of the body, or else is oxidized to produce heat and work.
9. Food is anything which, when swallowed, gives weight or heat to the body.

CHAPTER II

DIGESTION

14. Digestion. — We have seen how the little amebas can take food into any part of their bodies, and then can change it so that it becomes a living part of themselves. Each ameba has to seek its own food, and to take it just as it is found. The cells of our bodies have their food prepared for use and brought to them by a few of the cells of the body set aside for that special work. This food is the *blood.* All food eaten must become a part of the blood before it can nourish the body.

The preparation of food so that the cells can use it is called *digestion.* The object of digestion is to separate food from its hard and waste parts, and then to soften and dissolve it so that it becomes a liquid and can flow with the blood.

15. Cooking. — Man usually begins digestion outside of his body by cutting his food into pieces and heating or cooking it. By cooking most kinds of albumin are changed to a jellylike or solid form, like a cooked egg, but some kinds, like the connective tissue which binds the cells together, are softened. Cooking should leave food so soft that it can be chewed easily. Usually the longer food is cooked, the softer it becomes.

Cooking softens starch grains and causes them to swell and burst, and finally to dissolve in water, forming a thin paste. Man cannot digest raw starch, and so it must be

cooked if it is to be of any use to his body. Cooking does not change sugar.

Cooking simply melts fat, but does not change it, unless the heat is great enough to burn it. But in meat and vegetables, cooking softens the pockets of albumin in which the fat is stored, and sets it free, so that it floats upon the water. In this way pure lard and tallow are made.

Cooking develops the taste of food so that it is more agreeable to the body. It also destroys many poisons in food.

16. Ways of cooking. — Man applies heat in cooking in three ways. He boils the food in water, or surrounds it with heat in a hot oven, or exposes one side at once to the heat, as in broiling. It makes little difference how it is done, so long as it is done well. Cooked food should taste good and be either soft, or else brittle, so that it can be chewed fine. If food is tough or doughy, so that it cannot be chewed well, it is surely not well cooked.

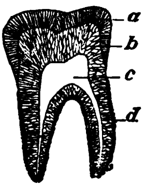
After the food is cooked we put it upon a plate and cut it into fine bits. This saves the mouth a great deal of work and keeps us from eating too fast. Every one should take time to cut his food into small pieces before eating it.

17. Mouth digestion. — After the food is cooked, man takes it into his mouth, and there continues its digestion by grinding it between his teeth and rolling it about with his tongue and cheeks until it is in fine particles. At the same time he mixes it with a watery fluid so that it is like a thin paste.

18. The teeth. — The teeth are bony pegs set into the jaw bones. Those in the front part of each bone are sharp in order to bite off lumps of food. Those in the back part of the mouth are flat so as to grind the food to pieces. Between the ages of six and thirteen years a

child loses his first set of teeth and gets a whole new set with eight additional ones.

19. Structure of teeth. — Through the center of each tooth there runs a small tube which contains a nerve and a blood tube. The outside of the part above the jaw is covered with a very hard substance called *enamel*, which protects the inner part from decay and injury. Biting hard things, like nuts or wood, often breaks the enamel, and then the tooth decays. When the decay reaches the nerve, the tooth aches and becomes very tender.



A tooth cut open.

a enamel.
b dentine or bone.
c pulp cavity containing blood tubes and nerves.
d cement.

20. Care of the teeth. — Bits of food sometimes get between the teeth, and if left there make the breath smell bad, and often cause the teeth to decay. A wooden toothpick used after each meal will best remove these bits of food.

A gray substance, called *tartar*, often collects upon the teeth, making them rough and dirty. One should keep this from forming by brushing the teeth with a toothbrush and water each morning and night. *Tobacco-chewing* stains the teeth almost black and causes them to decay quickly.

21. The jaws. — The upper jaw is a part of the bone of the face and cannot be moved. The lower jaw is a half circle of bone with its two back ends turned up. It can be moved up and down, forward and backward, and sidewise. By its movements it causes the teeth to act upon the food in every direction.

22. The cheeks and tongue. — The cheeks and tongue are made up mostly of muscles which can roll the food about in any direction. They have a fine sense of feeling,

so as to be able to judge of the position of the food and to tell when it is chewed enough.

23. Mucous membrane. — The mouth, as well as every other cavity of the body, has a thin lining called *mucous membrane*, which looks like a fine, soft skin. At the lips, nose, and other openings, this lining joins the skin so that it is impossible to tell where the one begins and the other ends. It is really a part of the skin turned inside the body. Mucous membrane is made of a network of cells and fibers, which is covered with an unbroken layer of firm cells called *epithelium*.

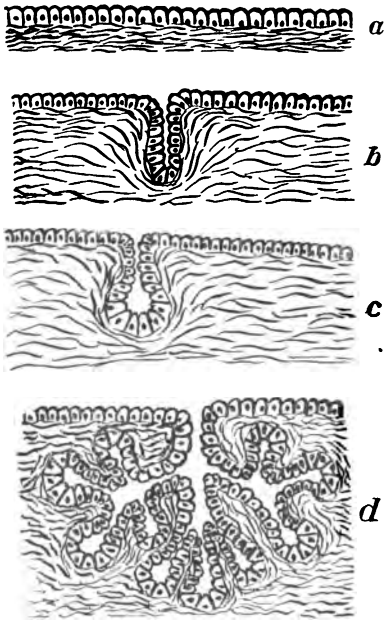


Diagram of glands.

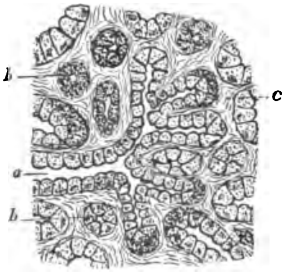
a epithelium upon the surface of a mucous membrane.
b the epithelium continued into a simple tube.
c the epithelium continued into a simple pocket.
d the epithelium continued into a series of branching tubes and pockets.
b, *c*, and *d* are glands.

24. Glands. — In each mucous membrane are tiny tubes which open upon its surface. Each tube is lined with cells of epithelium like those upon the surface of the membrane. The cells lining each tube produce a slightly slimy fluid called *mucus*. They pour just enough of it upon the surface of the membrane to moisten it.

A tube or collection of tubes whose cells can form a

continuous supply of a substance is called a *gland.* All mucous membranes contain enough mucous glands to keep their surfaces moist. In addition some mucous membranes also contain glands which produce other substances.

25. Salivary glands. — Upon the sides of the mouth are the openings of several small tubes through which a fluid called the *saliva* is always entering to moisten the mouth. While one is eating, more saliva flows, so that over a quart is produced each day. Each tube runs deep into the cheeks and suddenly divides again and again like the branches of a tree, so that the finest tubes cannot be seen without a microscope. Each tube is made of cells set edge to edge. These cells produce the saliva from the blood.



A salivary gland (× 200).

a tube of epithelium forming the gland, cut lengthwise.
b tubes cut crosswise.
c connective tissue binding the tubes in place.

Each bunch of tubes is rolled together, forming a mass about the size of a walnut. Each mass is called a *salivary* gland. There is a salivary gland in front of each ear, and two under each side of the jaw. In mumps these glands swell and produce lumps around the lower jaw.

26. The saliva. — The saliva is a watery fluid which flows very freely when anything is chewed. Saliva has a little power to change starch to sugar, but its main use is to dissolve the food into a thin paste which can be swallowed. The food should always be chewed so long as any lumps can be felt.

27. The pharynx and swallowing. — When the food has

been chewed to a paste, it is collected into a mass upon the back of the tongue, and pushed into a muscular bag called the *pharynx*. The pharynx has seven openings. Two into the nose and two into the ears can be closed by raising the back part of the roof of the mouth. An opening into the windpipe can be closed by a cover called the *epiglottis*. The opening into the mouth can be closed by two curtains, which slide across the back of the tongue and meet in the middle. The opening into the tube leading to the stomach is the only one left. When food reaches the pharynx, its muscles squeeze the food into the open tube leading to the stomach. Thus food is swallowed.

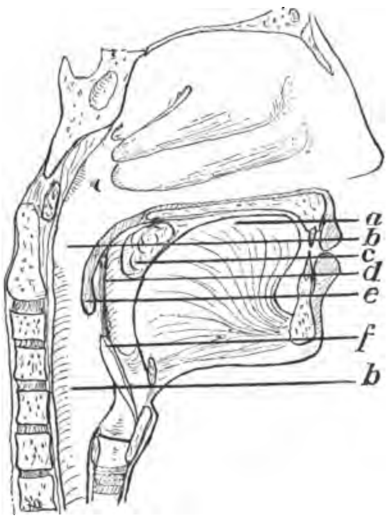


Diagram of the beginning of swallowing.

a top of tongue.
b pharynx.
c morsel of food.
d sliding door of the front of the pharynx.
e soft palate.
f epiglottis.

28. The esophagus. — The tube leading from the pharynx to the stomach is called the *esophagus*. The esophagus squeezes the food so that it is forced in the direction of the stomach. Each swallow of water in a horse's esophagus can be seen to run up its neck on its way to the stomach. Man's esophagus would look the same if it were near the surface.

29. The stomach. — The inside of the body is divided

into two parts by a sheet of muscle called the *diaphragm*. The upper part is called the *chest* or thorax, and holds the esophagus, lungs, and heart. The lower part is called the *abdomen*, and holds the stomach, intestine, liver, pancreas, and kidneys. The *stomach* is a thin bag of muscle lying upon the left side of the body, just under the lowest ribs. It is lined with mucous membrane, which contains very small tubes. These tubes are glands which produce a fluid called the *gastric juice*. The stomach squeezes and stirs the food about in a gentle manner, and mixes it with the gastric juice, so that in the course of an hour or two the food is ground and mixed, much as it was in the mouth.

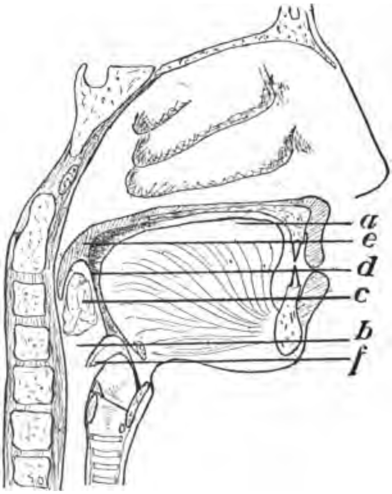


Diagram of second part of swallowing.

a top of tongue arched backward and upward.
b pharynx.
c morsel of food pushed into the pharynx by the back of the tongue.
d sliding doors of the pharynx which have come together in the middle.
e soft palate lifted upward to shut off the nose.
f epiglottis folded downward to close the larynx.

30. The gastric juice. — The glands produce about three quarts of gastric juice daily. It is mostly water, but it contains a small amount of a sour substance called *hydrochloric acid*, and of a white substance called *pepsin*. These two substances eat away or dissolve albumin, so that it becomes soft, and finally fully dissolves in the water of the gastric juice. Digested

albumin is called *peptone*. The stomach has no effect upon starch or fat. Only a small amount of the albumin is really changed to peptone by the gastric juice, for every few moments the opening leading from the stomach permits a small quantity of food to pass out. So food does not remain with the gastric juice long enough to be fully digested. The mixture of food and gastric juice leaving the stomach is called *chyme*.

Organs of the chest and abdomen.

a lungs. *d* stomach.
b heart. *e* liver.
c diaphragm. *f* intestine.

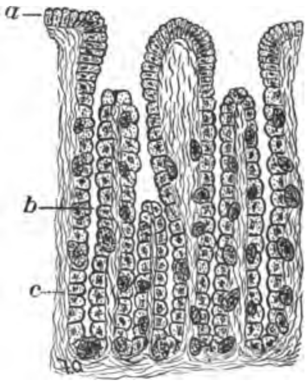
31. The intestine. — When food leaves the stomach it passes into a coil of a thin muscular tube called the *intestine*. The intestine is about twenty-five feet in length. Its upper four fifths is about an inch in diameter, while the lowest one fifth is about twice this size. Both parts slowly squeeze the food along, mixing it with three fluids, which act upon the food and change it to a liquid.

32. Intestinal fluids. — *First*. In the mucous membrane of the intestine are small tubelike glands. They pour out a liquid called the *intestinal juice*. The intestinal juice is small in quantity, and does not have much effect upon the food.

Second. Behind the stomach is a gland called the *pancreas* or *sweetbread*. Each day it pours into the intestine about a quart of a liquid called the *pancreatic juice*. This juice does most of the work of digesting food. It acts upon the albumin left by the stomach, and changes it to

liquid peptone. It changes starch to sugar, but far more powerfully than the saliva. It causes fat to become broken into fine particles, which will mix with water. It also changes some fat to soap.

Third. Above the stomach there is a large red gland called the *liver.* Each day it pours into the intestine about a quart of a yellow and bitter liquid called *bile.* Bile itself does but little of the work of digestion, but its presence doubles the power of the pancreatic juice. Bile is a waste substance, but on its way out of the body it helps in the work of building up the body.



Gastric glands in the stomach (× 200).

a epithelium of the surface of the stomach.
b epithelium lining the tubes of the glands.
c connective tissue between the tubes.

33. Movements of the intestine. — Like the mouth and stomach, the intestine mixes the food with the juices, and forces it along its tube. As food goes farther and farther down, it becomes more and more liquid, until at the end only such things as very large lumps of food, or husks and peelings, remain solid. The food now looks like milk, with undigested particles floating in it. It is still as much outside the body as though it were held in the closed mouth. It must pass through the wall of the intestine and enter the blood stream before it can feed the cells.

34. How food gets into the blood. — Many blood tubes lie almost upon the surface of the intestine, while many more lie upon tiny fingers called *villi,* which reach from

the sides of the intestine into the liquid food. Peptone and sugar easily soak into these blood tubes, and are carried to the liver. There the liver cells change the peptone back to a form of albumin much like that which was eaten. It is then fit food for the cells, and is sent to all parts of the body with the blood. The liver cells also change the sugar to a kind of starch. This is soon oxidized in the liver, and heat is produced for the use of the body.

Fat is soaked up by another set of tubes called *lacteals*. The lacteals begin in the villi, and finally empty the fat into a blood tube in the neck. The fat is then carried to the lungs, where it is oxidized so as to produce heat for the body.

35. Action of the bowels. — As the food slowly passes down the intestine, its liquid parts soak into the blood tubes, so that by the time it reaches the large intestine most of its water and all its useful parts have been removed, and only waste matter is left, which is driven on and out of the body. These waste matters should be expelled regularly at least once a day. If it is done at a certain time, the intestine will form the habit of always acting at that time. If the waste matters are not given off, we have headaches, and may become sick, for they poison the body.

36. Use of the liver. — If poisons are swallowed, they too are taken up by the blood tubes, and are carried to the liver. The liver cells strive to keep these poisons from going farther along the blood tubes, and thus they protect the body against bad food. So the liver has very important uses. When it gets out of order, it sends but little bile to digest the food. It lets poisons from the intestine pass by, and does not change the digested food to a form suited to the cells of the body. The result is a kind of sickness called *biliousness*.

37. Digestion of water and minerals. — Water and minerals need no digestion, but are taken up at once by the blood tubes. Water is always being poured into the mouth, stomach, and intestine by the glands, but is soon taken up again by the blood tubes. In all, about twelve quarts of water enter and leave these parts each day. As only two or three quarts are swallowed each day, the same water is used over and over again.

SUMMARY

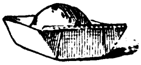
1. Making food a liquid so that it can reach and feed the cells of the body is *digestion.*
2. Cooking begins digestion by softening the food.
3. The mouth grinds the food and mixes it with the saliva which changes some starch to sugar.
4. The stomach mixes the food with the gastric juice, and continually stirs it about. The gastric juice dissolves some of the albumin to peptone.
5. In the intestine the bile and pancreatic juice change albumin to peptone and starch to sugar, and break the fat into fine particles.
6. Digested albumin and sugar soak into the blood tubes and are carried to the liver. Digested fat soaks into the lacteals, and is emptied into the blood stream in the neck.
7. The liver makes the albumin a part of the blood.
8. The liver changes the sugar back to a form of starch and oxidizes it, producing heat.
9. The liver also strains out poisons from the blood.
10. Digested fat is carried to the lungs, and is there oxidized.
11. Water and mineral substances enter the blood without being digested.

CHAPTER III

FOODS

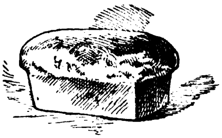
38. Kinds of substances in food. — A few hours after eating, all the food is used by the cells of the body, and then they ask for more through the feelings of hunger and thirst. To satisfy these feelings, man uses many different kinds of food, all containing either water, albumin, fat, starch, or mineral substances.

1 lb. of meat.



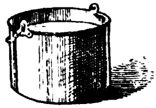
⅛ lb. of butter.

2 eggs.



½ lb. of bread.

3 pints of water.



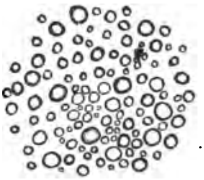
1½ pints of milk.

Food required daily by a healthy man.

39. Why sugar is fattening. — The fat of the body is formed from albumin. When much sugar is eaten, it is oxidized in place of the albumin and fat. These remain and make the body heavier. So we say that sugar is fattening. But sugar gives only heat and power to the body. Albumin gives weight, heat, and power, while water and minerals give weight only.

40. Difference in foods. — Water and mineral substances are the same everywhere, except as other things are mixed with them. They are found alike in all foods, and so far as they are concerned, it makes little difference what kinds of food are eaten. On the other hand, there are many kinds of albumin, fat, and starch, and it is the differences among these that make the difference in foods.

41. Milk. — Milk contains all kinds of food substances, for it has water, minerals, albumin, fat, and sugar. Moreover, these substances are in the best form for the use of the body. So milk is the most perfect food known, and is the only food which babies can eat.



Milk as it appears under the microscope (× 300). The drops are the fat.

42. Cheese. — Milk is one eighth solid matter. Of the solid matter the minerals form but a small part, while albumin, fat, and sugar each form about one third. The albumin becomes hard or curdled when the milk turns sour, and makes the milk like soft jelly. It is also curdled in the stomach in the first part of digestion. When curdled outside the body and freed from the water of the milk, it is called *cheese*. Cheese usually contains the fat of milk also. It is a valuable food.

43. Cream. — When milk stands for a while, its fat rises to the top and is called *cream*. If the cream is shaken in a churn, the fat collects in a lump called *butter*. Cream and butter are the most valuable forms of fat in food.

44. How to drink milk. — Some persons say that milk is harmful to them. It is likely to be so when a large quantity of cold milk is swallowed after a full meal is eaten. Think how a young animal drinks milk. It takes

it warm, upon an empty stomach, and swallows it very slowly. If a person will drink warmed milk, in sips, before he eats, it will rarely harm him. Children especially will find milk the best kind of food for them.

45. Eggs. — Eggs are about one fifth albumin and one fifth fat, and the rest is water with a little mineral matter. They have no starch or sugar, and so are not a perfect food for man. A perfect chicken can be formed from an egg, for the hen supplies the heat which, in man, comes from the sugar.

Eggs are easily digested, and form one of the most valuable foods in whatever form they are eaten. When boiled for at least ten minutes they are easily chewed fine, and are readily digested. Soft-boiled eggs are next in value.

Eggs which have been kept for some time are not desirable for food, even though they are not spoiled. They should always be fresh.

46. Meat. — Meat is the muscle of animals and birds. It is from one tenth to one fifth albumin, and has less than that amount of fat. It has some mineral matter, while the rest is water. It has no starch or sugar, and so is not a perfect food. But it is a valuable food, especially for the young. No child can be harmed by eating meat. In fact, he should have meat or eggs every day.

Meat which is salted or dried or canned becomes hardened so that the digestive juices act upon it less easily. So for young persons or persons with weak stomachs it is not desirable for food. Of all the different kinds of meat, beef is the most easily digested, and pork the least. Most kinds of fresh fowl and game are easily digested.

47. Fish. — Fish, crabs, oysters, and clams are forms of meat. If they are fresh and of good quality, they can

be eaten with as much safety as beef or pork. Raw oysters are especially valuable for sick people, for the dark mass which is often thought to be their intestine is really their liver and helps digest them.

48. Difference between animal and vegetable foods. — All animal food is more easily digested than vegetable food, and should be used by children and sick persons. It contains little or no starch, however, and some vegetable food must be eaten for the sake of its starch. All vegetable food contains some albumin and a large amount of starch or sugar and little fat. It is possible to live a healthy life while eating only vegetable food, but this is by no means the best kind of food.

49. Vegetable food. — Bread is about one half starch, and one fifteenth albumin, and hardly one seventieth fat. In it the albumin is more easily digested than in any other kind of vegetable food, yet less so than the albumin of animal food. It is not a perfect food, for the starch is in too large amount, but with meat or eggs it is a perfect food. With milk it is also a valuable food, especially for the young. Cake is much like bread, but it contains more sugar.

Potatoes have a large amount of starch and very little albumin, and no fat. They are good food with meat, but are hard to digest.

Beans are one fourth albumin and one half starch. For a strong person they are a valuable food, but weak persons find it hard to digest them.

Cereals, like corn meal and rice, are from two thirds to three fourths starch, and only one eighth to one fifteenth albumin. Only corn contains much fat, but all vegetable fat is hard to digest, and is of little value as food.

50. Fruit. — Fruit contains some starch and albumin

and a great deal of sugar; but all fruit is hard to digest, and little food is obtained. It is sometimes thought that the acids and flavors of fruit give some needed substances to the cells of the body, but their main use is their taste. Fruit is of use mainly because it is not digested; but, in passing down the intestine, it sweeps along food and waste substances, and thus keeps the intestine clean and in good condition. A great danger in using fruit is that it may sour and decay in the intestine just as it does outside the body.

51. Sweets. — Candy and sweet things of all kinds consist mostly of sugar, which is digested and carried to the liver. Thus, by eating too much of them, one eats too much sugar, and then the liver is overworked, and a bilious attack is produced. Nuts contain a great deal of albumin and oil, but both are in a form hard to digest.

Green vegetables, such as cabbage, lettuce, and beets, are like fruit, but contain even less food matters. They are of value mainly for their taste.

52. Spices. — *Spices*, such as mustard and cloves, burn the stomach just as they burn the mouth. They have no value as food, while by covering the taste of bad food they may be harmful. Still a little may improve the taste of food and so assist digestion.

53. Salt. — All the foods named have more than enough mineral substances, excepting salt, to supply the needs of the body. Salt is a great aid in the digestion of food. It also gives an agreeable taste to food. Food which has no taste can hardly be eaten, and after it is eaten it is as disagreeable to the stomach as it is to the mouth. Salt gives food an agreeable flavor. The saliva flows so that the mouth waters. In the stomach the gastric juice flows in the same way, and so the meal is easily and quickly

digested. Fruit, nuts, and similar foods act upon the taste in the same way as salt.

54. Bad food. — Food which smells or tastes musty or decayed is always unfit for food and may be poisonous. Spoiled milk or cream is the worst of all. Young children and babies should never drink milk which is the least sour. Moldy bread or meat may cause sickness of the stomach and great pains in the lower part of the body. The food of diseased animals is as bad as spoiled food. Canned food should not be opened until it is to be eaten, for it soon spoils when exposed to the air.

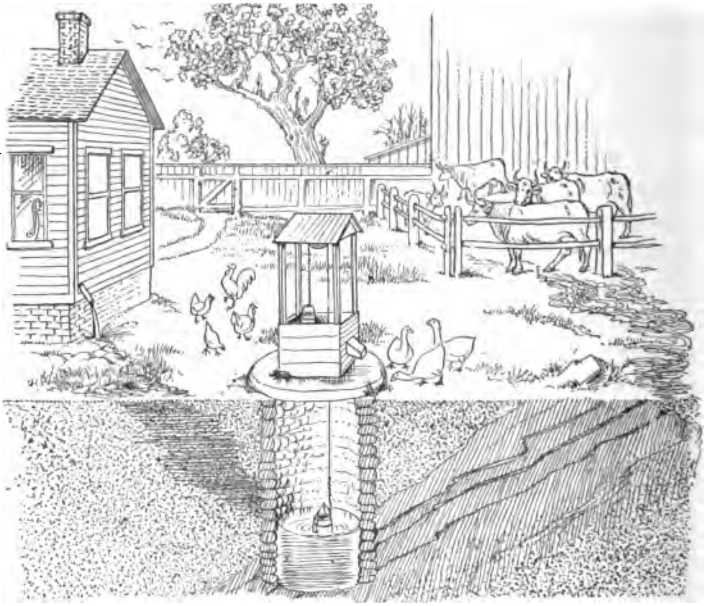
Unripe fruit cannot be digested at all unless it is cooked. Green apples or cherries are not fit for any one. In them the starch and sugar are like the starch in grass. But by thorough cooking they may sometimes be made harmless.

55. Diseased food. — Food may contain disease germs. Consumption is often caught in this way. Meat is the most often diseased; and of meat, pork the most often contains disease germs. Cooking destroys the germs. So we should never eat raw meat.

56. Choice of food. — The different kinds of meal and flour are almost the same in price. Meats, fish, and vegetables of the same food value differ greatly in their cost. The variety of foods, or their good appearance, or their unusually fine taste makes them high-priced. What is called the *best* food may look and taste better, but is often no more nourishing than cheaper food. The cheaper meats and fish furnish good food at half the cost of the best kinds. If they are well cooked, they will taste as good as the best. Plain flour and meal are cheap, but prepared and ready mixed kinds cost far more and are no better for food.

57. Water. — Water is also a food, but we call it a drink. Water itself is everywhere the same, but different sub-

stances dissolved in it make it good or bad for use. Really pure water has a flat taste, and is unfit for drinking. Air in the water gives it a pleasant taste. Water often dissolves lime from the soil so that it does not easily form a lather with soap. We call such water *hard.* Rain water is *soft*, for it has no lime.



How impurities may get into a well.

58. Impure water. — Water dissolves many substances over which it runs, but only a few of these are harmful. When it stands in lead pipes for some hours, it dissolves a little poisonous lead. If the water that has stood in the pipes is thrown away, the running water will be safe for use.

Almost the only other dangerous substance found in

water is decaying matter. Decaying slops from the house or barnyard are very poisonous. They sometimes soak into the well and poison the family. Disease germs cannot grow in pure water, but they easily grow in water containing decayed substances. Sometimes the germs of typhoid fever get into the water of a well and grow, producing the disease in those who drink the water. Water may be impure even if it tastes good and looks clear and sparkling. The surest way to keep the water pure is to locate the well so that no slops or barnyard drainage can reach it.

59. How to purify water. — If impure water must be used, the disease germs may be destroyed by boiling it for ten minutes. This also drives out the air and makes the water taste flat, but if it stands a few hours, it takes up air and becomes fit for use. Water can be somewhat purified by passing it through sand or powdered charcoal or some other powdered substance. An arrangement for this purpose is a *filter*. A filter removes mud and coarse particles, but it does not take out all the disease germs.

60. Amount of water needed. — A grown person needs about three quarts of water daily. He will take half of this with his solid food, leaving about a quart and a half to be drunk extra. We should drink about this amount of water daily. The time of drinking is not of great importance. Some should be taken at meal times, and, if the meal is eaten slowly, it can do no harm. All drinks, of course, contain water which should be counted as so much ordinary water.

61. Tea and coffee. — Tea and coffee are not food, but they act upon the mind so that the body does not feel tired when hard work is done. By using a large amount of tea and coffee it would seem that more work can be done, yet

they do not add to the strength of the body, but only benumb its tired feelings. A substance which causes the body to do more work without giving extra strength is called a *stimulant*. The old Romans called an ox whip a *stimulus*. So a stimulant is anything which acts like a whip.

62. How much food? — In all, about one fourth of a pound of albumin, and a little more than a quarter of a pound of starch, and a little less than a quarter of a pound of fat should be eaten each day. What food shall we select to furnish these substances? Men live upon every kind of food, but some foods are better than others. This bill of fare for the day will give the right quantity of food:

1 lb. of meat, or eggs, or fish;	2 oz. of butter;
½ lb. of bread; 3 pints of water;	1½ pints of milk.

SUMMARY

1. All animal food contains a good quantity of albumin and fat, and but little starch or sugar.
2. Vegetable foods contain albumin, but it is much harder to digest than the albumin of animal food.
3. Vegetable food contains some oil, but this is scarcely digested at all.
4. Vegetable food contains a very large quantity either of starch or of sugar.
5. The best bill of fare contains animal food to supply the albumin and fat, and vegetable food to supply the sugar or starch.
6. Salt is the only mineral substance which needs to be added to food.
7. Almost any kind of water can be made safe for drinking by boiling it for ten minutes.

CHAPTER IV

INTEMPERANCE AND POISONS

63. Why men are intemperate. — If a man should eat as nature intended, he would always be strong and healthy. In caring for animals we feed them only one or two kinds of food, and are very careful not to overfeed them. If they have too much food, or too many different kinds of food, they become sick. We sometimes say that a person has the stomach of an animal, for nothing seems to hurt him. But if the stomachs of animals were treated as the stomachs of men are commonly treated, animals would become sick sooner than men.

Improper eating and improper drinking produce more ill health than all other causes put together. Many parents feed their children with sweets and candy. Some give them tea and coffee, and some give them beer or wine. These things create a craving which increases its demands if it is gratified, and thus paves the way for the desire for strong drink.

Man is surrounded by an abundance of all kinds of good food, and is given a plenty of time for eating it. Yet, in spite of his knowledge and opportunities, he often makes himself sick by his eating and drinking. He is led to do this by making a wrong use of the very feelings which should teach him how to eat properly.

64. Hunger and thirst. — Nature has given man signs so that his mind may know when and what kind of food

to eat. The sense of taste is a sure guide as to the kind of food that is needed. Man never tires of bread and meat, but he does tire of spices and sweet things, which are not proper foods. Hunger, or the appetite, is a sign when food is needed. Grown people get hungry about every six hours, and children more often. When enough food has been eaten there is a feeling that the hunger is satisfied. If we should always heed these two signs, it would be much better for us.

65. False appetites. — But we can teach the taste and appetite so that they are no longer sure guides. After a full dinner has been eaten, and when the appetite has been satisfied with plain food, a dessert made of sweets, spices and jellies is brought in. This at once makes a new appetite, and man satisfies it for the sake of his pleasure. So he does two wrong things to his body. First, he puts too much food into his stomach; second, he eats too much sugar. The sugar overworks the liver, and he is very liable to have a bilious attack. We need a little more sugar than fat, but we often eat many times as much. A natural appetite is satisfied with three meals a day, but the false appetite leads us to eat cake, candy, and fruit at all times. We seldom want to eat bread or meat between meals. This shows that the cells of the body are not calling for food. By eating at all hours we keep the stomach at work without rest, and it soon tires itself out.

66. Too fast eating. — When we eat too fast, the food cannot be chewed fine, but is swallowed in lumps. Then the stomach must do the work which the mouth should do. Besides, it does not have time to give notice that its wants are filled, and so we eat too much. When we need to wash food down with water, we are surely eating too fast, but drinking at meals to satisfy a natural thirst is proper.

Our appetite sometimes leads us to drink very hot or very cold water or tea. Although we cannot feel either in the stomach, yet both disturb digestion.

One form of intemperance.

67. Intemperance. — Man is almost the only living being that eats all kinds of food for the mere pleasure of eating. Animals follow their natural appetites, and their stomachs are healthy. Man eats to satisfy new appetites, and harms his stomach so that it cannot digest even plain food. We should be far better off if we never touched sweetmeats, pie, and cake, but lived only upon bread and meat and other plain foods.

Satisfying an appetite which does not indicate a need of

the body is *intemperance.* Almost everybody is intemperate in eating from the time he can walk, to old age. Intemperance in eating is very liable to lead to intemperance in drinking later in life.

Eating and drinking *anything* for mere pleasure is *intemperance* and harms the body. We may not see the harm of eating a single apple in the middle of the forenoon when we are not hungry; and yet this is an act of intemperance, and, if repeated, tends to overwork the stomach and to produce dyspepsia, and possibly a fever. Eating some other things, such as green apples, nearly always produces sickness, and we at once see that it is a form of intemperance. But eating the first apple was intemperance just as really as eating the green one.

A little pie or cake may be used in place of food, but every one knows that eating very much of it is intemperance and produces sickness.

In some cases a great deal of intemperance does not seem to do harm at once, and so men will risk being sick for the sake of a moment's pleasure. They do not count the cost when they are feeding an appetite.

68. Appetite for strong drink. — Using drinks which contain alcohol is the worst form of intemperance. It is such a bad form that, when we speak of intemperance we usually mean the use of strong drink.

We can eat pie or cake or candy without being intemperate; but *any* use of strong drink is intemperance, for it is not needed at all by the body, but is used only for pleasure. Its does such harm that no one can drink much without plainly showing its effects.

When we have been intemperate in eating pie or cake we feel sick and could not eat more if we would. When a person is harmed by strong drink the drink often makes

him feel well while he is slowly killing himself. This power of strong drink to deceive a person into using it while it is slowly harming him makes it the worst form of intemperance. It affects every part of the body. These effects will be described fully as we study the different parts of the body.

69. Tobacco intemperance. — Next to using strong drink, the use of tobacco is the most harmful form of intemperance. It does not always do so much harm as strong drink, for it usually acts so slowly that we do not notice its effects. Like strong drink, it makes a person feel well while it slowly poisons him. It often does great harm to different parts of the body. These effects will be described as we study each part.

70. Sickness. — When each cell of our body does its work perfectly, and when all the cells work together, we are well and healthy. When one set of cells is out of order, it affects all the others, and we are sick. Thus, if the cells of the stomach fail to digest food, all the cells lack food, and so the stomach makes the whole body feel sick. The doctor then comes to see what was out of order first, and tries to correct its action so that we may be well again.

71. Drugs. — When a person is sick, the doctor often gives him substances which are called *drugs*. They are not food, and even if they were, they are in too small amounts to furnish much nourishment. In the stomach and intestine they are taken up with the food, and are carried by the blood to the cells of the body. There they cause the cells to act in a more natural manner. When the cells finally act as usual, we are well again. For instance, in a bilious attack, the doctor gives a pill or powder, which is taken up by the blood and carried to the liver.

There it causes the liver cells to act more strongly and to produce more bile. In a short time, the liver is acting right again, and we are well. In the same way, other drugs act upon other parts of the body and make them act rightly when they are out of order.

72. Poisons. — A little of a drug causes the cells of the body to act in a more natural way. Too much of a drug either causes them to overwork, or else stops their action, in either case producing sickness. Substances which interfere with the work of the the cells are *poisons*. So all drugs and narcotics are poisons if taken in too great amounts. For this reason, we should never use them unless we are guided by some one who understands their use.

73. Signs of poisoning. — When a person is poisoned, he suddenly becomes very sick and weak. There is no sickness that will come on so suddenly as that caused by poisoning. The sufferer's mind will probably be affected, and he will be much alarmed for himself.

74. How to help a poisoned person. — When a person is poisoned, the first thing to do is to get rid of the poison as soon as you can. This you will do by making the person vomit. You can always do this at once by running your finger down his throat as far as possible. Do not get frightened, but at once either ask the person to do it himself or to let you do it.

You will also help vomiting by having the person drink as much water as possible. This will also wash out his stomach and get rid of more of the poison.

You will also aid vomiting by giving a tablespoonful of mustard mixed in water. The point is to get the person to vomit as soon as possible. By remembering this, you may be able to save a life.

A poisoned person will feel very weak after he has

vomited. So you must give him a stimulant. Some strong coffee will be the best of all. You will do him no harm by giving it.

Finally, keep the person quiet, for in his weakness he cannot stand much exertion in moving about.

75. Spoiled food or poisonous food, such as some varieties of mushrooms, causes great pain in the lower part of the body, and great weakness. When this comes on, vomiting should be induced at once. Often the stomach will vomit the food of its own accord, and so nature cures the poisoning. When a person vomits, it usually means that some poison is upon the stomach.

76. Opium poisoning. — The most common form of poisoning is that by opium. Opium is the dried juice of the poppy plant. It is used to produce sleep and to relieve pain, and is a strong poison. A piece as large as a grain of corn could put a man into a deep sleep, and three or four such pieces might kill him.

People often keep different kinds of opium in the house. *Laudanum* is opium dissolved in nine times its weight of alcohol. *Paregoric* is a weaker form of opium and alcohol. Most *soothing syrups* which are used to quiet children, act by means of their opium. They can easily poison a baby. *Morphine* is a powder made from opium, and is ten times as strong as opium itself.

You can tell opium poisoning by the deep sleep which it produces. A poisoned person should be made to vomit, and afterward he should drink some strong coffee. You should also keep him awake by making him walk or even by striking him with a whip; but do not bruise his skin.

77. Carbolic acid poisoning. — Carbolic acid is often kept in houses for use as a wash during sickness. If it is swallowed it will burn the throat and stomach, leaving a white

scar. The person will feel very sick and may faint away and become insensible. You should give him milk or raw eggs. Then give Epsom salts, which will tend to stop the action of the poison. Carbolic acid, when used as a strong wash, may injure the skin, and cause sickness as if it had been swallowed. Treat the person as if he had swallowed the poison.

78. Arsenic. — Paris green, London purple, and most other rat and insect poisons are forms of arsenic. When swallowed they produce vomiting and great pains in the stomach. A very little of the poison will cause death. Give the poisoned person milk and raw eggs.

79. Insect stings. — Bees, hornets, spiders, mosquitoes, and other insects sometimes inject a little poison beneath the skin when they bite or sting. This produces a swelling and great pain as though something were burning the skin. If a number of stings are made there may be enough poison to make a person very sick.

The pain of bites and stings can be relieved by applying a lump of cold mud at once. Some carbolic acid water, lime water, ammonia, or camphor will also help.

80. Snake bites. — In the United States there are but few kinds of snakes that bite, and still fewer whose bites are poisonous. A snake bite is like that of a very large and poisonous insect. The bitten part swells and becomes very painful, and the person feels weak all over.

You should tie a handkerchief above the bite as soon as possible, so as to keep the poison from going through the whole body. Then suck the bite so as to take out the poison, being careful to spit out the blood and poison. You should cut open the bitten part so as to let the blood flow and wash away the poison. You should also give strong coffee or other stimulant.

SUMMARY

1. The taste and the appetite are two sure signs of when and how much food to eat.
2. Man spoils these signs by eating sweet and spicy foods at all hours for the sake of the pleasure of eating, and by eating too fast.
3. Eating for the pleasure of eating when the body does not need food is as real intemperance as taking strong drink.
4. Sickness is due to the imperfect or stopped action of some of the cells of the body. Drugs are then given to cause the cells to act rightly again.
5. Too much of any drug hinders the action of the cells, and so is a poison.
6. When a person is poisoned, cause him to vomit by putting the finger down the throat, or by giving him large drinks of water, or by giving him mustard and water.
7. Also give a poisoned person strong coffee.

CHAPTER V

TOBACCO

81. Narcotics. — Besides eating his natural food, man often forms a habit of eating things which harm him, and yet he uses them because he learns to enjoy their taste or the feelings which they produce. Most of these things belong to a class called *narcotics;* they benumb pain and weaken both the brain and the body. At first, both these substances themselves and also the feelings which they produce are unpleasant. Men learn to like their benumbing effects, and soon get into the habit of their use because they take away pain and calm a person when he is nervous or worried. The most commonly used narcotic is tobacco.

82. Tobacco. — Tobacco is the leaf of a tall plant. It requires a richer soil and more care than any other crop. Soil which raises tobacco is kept from raising a great quantity of real food. A few crops of tobacco take so much richness from the soil that only small crops of anything else will grow afterwards.

The leaves of tobacco contain a narcotic poison called *nicotine.* Nicotine gives the tobacco most of its smell and taste, and if it is taken out, the tobacco is spoiled. It is easily turned into a vapor, and is found in the smoke when tobacco is burned. It is so poisonous that the smoke of two or three pipefuls of tobacco contains enough to kill a man if it should stay in his body. A single drop of it can kill a strong person. Tobacco is sometimes made into a

poultice and put upon a sore. The nicotine from the poultice has been known to poison the body, and even to produce death. The nicotine of a few puffs of smoke makes a person very weak and sick when he begins to smoke. This shows how poisonous it is. After a person has smoked a few times he becomes used to the poison so that he can smoke or chew a great deal without becoming sick, but a larger amount than usual sickens even an old smoker.

83. Why tobacco is used. — Persons make many excuses for using tobacco. One says it is company for him. Another says it makes his head clear so that he can think better. Some smoke because others do, and boys smoke because they think it makes them look like grown men. Some say that they smoke to help digest the food, and some that they use tobacco so that their stomachs will not need so much food. Some smoke to cure a cold in the head. Some boys learn to chew by putting tobacco in a decayed tooth, thinking it will stop toothache. It is easy to find an excuse for using tobacco, but where so many excuses are given, none are good.

84. Why tobacco should not be used. — There are many reasons why a person should not use tobacco in any form. It always leaves an unpleasant odor about the clothes and room, and upon the breath. A person who cares for the feelings of others will not make himself disagreeable with the smoke of tobacco.

Chewing and smoking make more saliva flow than the mouth can take care of. The spitting which this causes ought to keep any one from using tobacco. Tobacco does not help digestion, but those who use it are very apt to have a coated tongue and headache, showing that their food is not digested as it should be. Many also have a sore throat and a cough and a husky voice as the direct

result of using tobacco. The worst effects are that it sometimes causes weakness of the heart and poor sight, or even blindness. These effects will be studied later.

All these bad effects can be produced in those who breathe the smoke in a room. Babies can easily be made sick by tobacco smoke in a room with them. The young are far more easily poisoned by tobacco than older persons. In the young the weakness caused by tobacco is often so great as to hinder the growth of the body. Boys who wish to grow to be large men had better not use tobacco. In a crowd of boys it is often possible to pick out those who smoke by their smaller size, the thinness of their flesh, and their pale, pasty complexion.

85. Smoking. — Tobacco is used either by smoking, chewing, or as snuff. All tobacco smoke is poisonous, but the stronger the tobacco, the more poisonous it is. The burning also makes poisonous gases, one of which is a dangerous gas like that used in lighting houses. The poisons stay in the stem of a pipe which has been smoked for some time until so much collects that it makes even an old smoker sick. The smoke of a pipe contains more poisons than the smoke of a cigar, for the cigar is more completely burned up.

86. Cigarettes. — Cigarettes are made from mild tobacco and contain less nicotine, yet the danger from using them is still greater, for the smoke is easily drawn deeply into the mouth and often into the lungs, and so more of the poison is apt to reach the cells of the body.

87. Chewing. — Chewing tobacco is a dirty habit which has no excuse beyond the pleasure men learn to take in it. No man who prides himself upon the good looks of his teeth and lips will chew tobacco. It is the most poisonous of all the forms in which tobacco can be used.

88. Snuff. — Taking snuff is going out of fashion. Snuff is used to produce a sneeze. It may be fun to make oneself sneeze, but snuff is poisonous and is a bad thing to use for this purpose. A sneeze is really an attempt to drive out something which is hurting the nose. Surely it does not pay to hurt the nose for a sneeze.

We all know of men, and even women, who chew and smoke every day and yet live long and healthy lives. If tobacco evidently harmed every one who uses it, the law would have stopped its use long ago. But because its hurtfulness shows itself only slowly and because the body can become somewhat used to it, men say it is harmless, and some even say it is good for the body. The truth is that tobacco will surely do a great harm to at least one quarter of those who use it, and may harm the others at any time.

89. Opium. — Opium is another narcotic which men learn to use. It is the dried juice of the poppy plant. It stops pain, produces sleep, and gives nervous people a calm and contented feeling. Many different substances in the opium can do this, but a white substance called *morphine* is the main one. In large doses, opium or morphine causes deep sleep and great weakness of the body until death occurs. In small doses it hinders the work of the stomach and intestine, so that food is not digested as it should be. So the body loses weight and strength. The body may get used to the drug so that more and more is needed to quiet the nerves. It always weakens the body and causes death in a few months or years. The opium habit is one of the hardest to break. Some use opium by smoking it like tobacco.

90. Chloral. — Chloral is a solid with a sharp, peppery taste. It is used much like opium. It calms nervousness

and causes sleep, but it poisons the body and produces death even more quickly than opium.

91. Narcotic poisoning. — Poisoning by opium and such drugs produces sleep. So the poisoned person must be kept awake. One must shake or pinch him, or, in fact, do almost anything to arouse him, for if he gets sound asleep he is liable to die.

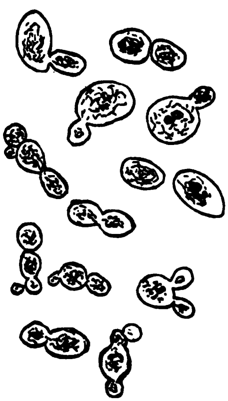
SUMMARY

1. Men use narcotics to benumb pain and to dull the brain so that it does not worry.
2. Tobacco is a narcotic which depends upon a poison called *nicotine* for its effects.
3. Tobacco is smoked, chewed, and snuffed up the nose. In all three ways, nicotine enters the body.
4. Tobacco not only harms those who use it, but its use is unpleasant to those who do not use it.
5. Opium is a narcotic used to produce sleep and to quiet pain. Its use always does great harm, and if continued produces death.
6. Chloral is used like opium, and is even more deadly.
7. A person must be kept awake when he is poisoned by a narcotic.

CHAPTER VI

ALCOHOL

92. Yeast. — A narcotic which man often takes into his body is alcohol. When a little sugar in water stands a while, bubbles of carbonic acid gas rise up through the water, and the liquid turns sour. If one puts more sugar in the water, the bubbles will rise, but the liquid has a strong odor and a sharp taste, for some of the sugar has turned to alcohol. We say that the sugar ferments. When there is a great deal of sugar in the water, it does not ferment at all. Let us seek the causes of these changes.



Yeast plant cells (×500).

In the air there float tiny germs of a living plant called the *yeast* plant. When these germs fall into sugar and water they grow, and produce great numbers of yeast plants. Each yeast plant is only a single round or oval cell, so small that a microscope is needed to see it. By its growth it changes the sugar to *alcohol* by taking some carbonic acid gas away. But if there is a great deal of sugar in the water, the germs will not grow at all. This is why fruit preserved with a great deal of sugar keeps so well.

93. Souring. — If there is only a little sugar in water, a smaller germ from the air grows with the yeast. This

changes the alcohol to *vinegar*, which makes the liquid sour. Changing sugar to alcohol or vinegar is *fermentation*. All strong drink contains alcohol, and is made by the fermentation of sugar. Alcohol is sugar with some of its carbonic acid gas taken away.

94. Alcohol. — Alcohol is a colorless liquid which burns very easily, with little flame and no smoke, but with a great deal of heat. It has a sharp, sweetish taste and smell. It turns to vapor very easily. It takes water away from substances, and causes them to shrivel up. It hardens albumin, just as heat hardens the white of an egg. Because it hardens substances and takes away their water, it is used to keep things from decaying. It is used for dissolving many things which water would not affect; and from it ether, chloroform, and numberless other useful things are made. It is a very valuable article, and manufacturers and chemists could not do without it. But man has learned that its taste gives him pleasure, and that the feelings which result are often very pleasant. So day after day men drink liquors containing it for the mere pleasure of drinking.

Fermentation in a jar of cherries.

95. Why men drink. — Men are ashamed to waste their money and strength in mere pleasure, and so they make excuses for using the strong drink. One man says that it warms him, and another that it cools him, and another that it makes him forget his cares while he remembers only pleasant things. One takes it to keep himself awake, and another to make himself sleep. Some take it to cure a

pain or a cold, and many drink because others do. The real reason for drinking alcohol is that men like the feelings which it produces better than they like healthy minds and bodies. Because strong drink can be sold for a great deal more money than it costs, selling it is a very profitable business, and men fit up costly rooms so as to entice men to buy it.

96. **Effect of alcohol upon the mouth.** — Alcohol is a poison which has definite effects. It usually has effects opposite to those that men think it has. As it is swallowed, the alcohol in all drinks injures the cells of the surface of the mouth and leaves a false feeling of thirst. So a second drink is taken to relieve the thirst caused by the first. Thus the drinker keeps on drinking, and all the while grows more thirsty, even though his body has sufficient water. His mouth gives off unpleasant odors, but this is due in part, at least, to the coated tongue and sick stomach which drink causes.

97. **Effects of alcohol upon the stomach.** — In the stomach, the alcohol of strong drink hinders or stops the action of the gastric juice. So food may digest more slowly or pass into the intestine without being changed. The alcohol also hurts the mucous membrane of the stomach. Then this may become red and pour out a slimy mucus. The alcohol often causes a person to vomit. This is really a good thing, for so the stomach gets rid of the poison.

98. **Protection against alcohol.** — When strong alcohol is taken into the mouth, the saliva flows freely and dilutes it so that it is no longer capable of burning the mucous membrane. This flow of saliva is like the flow of tears to wash away a speck of dirt from the eye.

When alcohol reaches the stomach, the glands in its mucous membrane pour out gastric juice and mucus to

dilute it just as the mouth poured out saliva. If it were not for this protection, a drink of strong liquor would quickly destroy the stomach. Our bodies can stand a great deal of abuse, because nature has provided us with protection against all ordinary abuse. Still, after a time, the drinking of alcohol and all other abuses are certain to do great harm.

99. Digestion of alcohol. — Alcohol itself needs little or no digestion. After it has been much diluted by the fluids in the stomach and intestine, it soaks into the blood tubes along with the food of the body. There it is washed away in the rapid blood stream, so that not enough collects at one time to damage the blood directly. It is carried to the liver and there disappears at once. Little or none can ever be found in the body beyond the liver. It is probably oxidized like sugar, only very much more rapidly.

100. Poisons produced by alcohol. — Destroying or oxidizing alcohol uses oxygen, so that there will be too little left for the body and its food. When a stove gets too little oxygen through its draft, it produces poisonous smoke. If the albumin, sugar, and fat of the food get too little oxygen, they, too, give rise to foul substances. These new products go through the whole body with the blood, and produce far more poisonous effects than alcohol itself. Even after alcohol is destroyed, its harm continues as great as ever.

Trying to use alcohol as a drink is like trying to burn kerosene in a coal stove. By using great care a little kerosene can be burned without doing much harm, but it smokes and smells bad and cannot be controlled. Alcohol behaves like the kerosene. It gives rise to poisonous substances, and may overcome the body at any time.

101. How alcohol weakens the cells. — When alcohol is

used, the cells are weakened and poisoned both by the alcohol and by the half-burned albumin, sugar, and fat. Then they fail in their attempts to do their work. So walking is done in a staggering way, and the voice is thick and uncertain. A man in this condition is said to be ***drunk***. The alcohol may make him still weaker, so that he cannot stir, but lies dead drunk, or he may even be killed by the alcohol. At first we might think that the destruction and oxidation of alcohol would develop heat and force which the body could use. But it must be remembered that the cells themselves are made weak, both by their lack of oxygen and also by the poisons of the half-burned albumin and fat. If an engine is weak and rusty, a hot fire under the boiler will not make it do more work, but it may cause the whole machine to be blown up. A few men seem able to drink for years, and yet remain in fair health. A little alcohol will do great harm to most men. At any rate, drinking will not help men in their work or help them to live better lives.

102. Effects of alcohol upon the liver. — The liver itself suffers from the alcohol. It has to take care of the heat and of the half-burned albumin, fat, and sugar, and of all the poisons which are produced. So it is over-worked and often fails in its duty. Thus, a drinker is very apt to have bilious attacks. If drinking is kept up for some time, the liver often wastes away, and becomes hard and rough and unable to do its work. Physicians long ago called such a liver a "gin drinker's" liver. When the liver has been harmed in that way by alcohol, the body slowly wastes away, and finally death occurs as much by starvation as by poison. Because alcohol disturbs both the preparation of the food of the cells and also its oxidation, it affects every cell in the body. These effects will

be told when the work of each separate set of cells is studied.

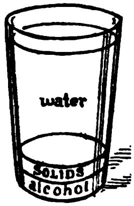
103. Habit of drinking. — While alcohol is harming a man, it makes him feel good, so that he does not think of his danger. At first he drinks only a little, but it seems to make him feel good. After it has gone out of his body, he feels its harmful effects. Then he wants another drink, so as to make himself feel well again. This desire to take alcohol may compel a man to drink, even when he knows that it is harming him. Strong drink is like a man who visits at another man's house, but is all the time robbing him.

104. Laws against selling alcohol. — If alcohol harmed only the body of the person who uses it, it might not concern any one except the drinker himself. But it does other things beside which the effects upon the body are of less account. It takes away a person's mind and character so that a truthful and honest man becomes untruthful and cannot be trusted. He is thus very apt to injure others, and even his dearest friends. Every day we read of drunken husbands beating their wives and children. Many a criminal has had to get half drunk before he has dared to commit his crime. Thus many have to suffer because one man wants to have the pleasure of drinking. Strong drink harms not only the drinker, but also his friends and neighbors. So it is right to make laws which shall keep a man from selling alcohol and strong drink. School children are now learning how bad alcohol is, and when they grow up they will know better than to use it.

105. Form of alcohol in drinks. — The effects of alcohol are the same in whatever form it is taken. Pure alcohol has an unpleasant taste and burns the mouth of even an old drinker. So in drinks it is always mixed with water.

106. Wine. — We have seen how the yeast plant causes

sugar and water to ferment to alcohol. Fruit juice contains sugar dissolved in the water of the juice. The simplest way in which an alcoholic drink is made is to squeeze the juice from the fruit and let it ferment in open bottles or barrels. There are always enough germs of the yeast plant upon the outside of the fruit to start the fermentation, and in a few weeks or months the sugar of the juice has turned to alcohol. The strongest liquor made in this way can be only one eighth alcohol, for more than that kills the yeast plant. When grape or cherry or blackberry juice is used, the liquor is called *wine;* but if apple juice is used, it is called *cider.* It all contains alcohol. Cider begins to ferment in a few hours after it is made, and in a week it often has enough alcohol to make a person drunk. In a short time other germs enter the cider and change the alcohol to vinegar. Homemade wine contains alcohol, and its use is as harmful as though it were bought at the saloon. Some wine has pure alcohol added to it to make it keep better.



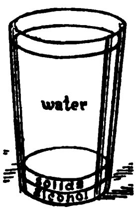
What wine contains.

Since wine is made of fruit juice, it may contain some albumin, which is of value as food, but to buy wine is a very expensive way to buy albumin, and besides the albumin of wine is not nearly so good as the albumin of bread or meat. Wine may contain some unfermented sugar also.

The flavor of wine depends upon the kind of fruit and the amount of fermentation. It has little to do with the amount of alcohol in the wine. Fermented fruit juice was the only kind of alcoholic drink which people knew in ancient times. It was weak in alcohol, and a great deal was needed to make a man drunk. Much of the wine

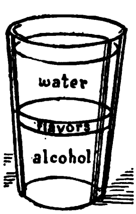
which we read about in the Bible was fresh grape juice used before fermentation had begun.

107. Beer. — The alcoholic drink which is most used is beer. Beer is made chiefly from barley. The grain is moistened, and each seed begins to grow. This turns the starch of the grain to sugar. When the sprouts are about half an inch in length, the grain is dried. This dried grain is called *malt*. The malt is boiled in water so as to dissolve the sugar. The liquor is strained off, and hops and other flavoring matters are put in. Then yeast is added, for the boiling kills the yeast which was there at first. Fermentation takes place and changes the sugar to alcohol. Beer is about one twentieth alcohol, but some is a great deal stronger. Beer, like wine, contains some albumin, but the best beer or ale has little of the food part of the grain of which it is made. Some men drink three or four quarts of beer a day. This makes them fat, but it does not give them strength.



What beer contains.

Root beer is made at home by boiling aromatic roots and leaves with molasses and adding yeast to the liquor. The molasses ferments and becomes alcohol. All root beer has alcohol in it.



What whisky contains.

108. Distilled liquors. — When a pot of alcohol and a pot of water are set upon a stove together, the alcohol begins to boil much sooner than the water, and is sooner turned to vapor. If water and alcohol are mixed together and heated, the alcohol makes the largest part of the vapor, and is at last driven off before half the water is gone. If this vapor is collected and cooled, it becomes a liquid, and con-

tains far more alcohol than the first liquor. If this liquor is boiled over and over again, the alcohol is further separated from the water until it is almost pure. Separating alcohol from water by heating is called *distillation*. Many liquors are made by distillation. If wine is distilled, the liquor is called *brandy*, but if grain is used to make the alcohol, it is called *whisky*. Brandy and whisky are each about one half alcohol. When first made they contain a very poisonous kind of alcohol. They are both kept for months, and even years, before being used, so as to change this more poisonous alcohol to common alcohol.

109. History of strong drink. — The germs of yeast grow almost everywhere. By their growth alcohol is always formed wherever fruit decays or its juice has an opportunity to collect. For thousands of years men have known the taste and the effects of fermented liquors, and how to produce the fermentation. Almost every known race of men has made wine from the earliest times. Noah made wine shortly after the flood, and wine is mentioned in many places in the Bible. In the earliest recorded times people of Egypt and of Assyria used wine on their tables and often made themselves drunk. The native Mexicans had an intoxicating liquor when the Spaniards came in the early part of the sixteenth century. But the ancients never used drink so strong as it is made now, for fermentation stops when the juice becomes one eighth alcohol.

About eight hundred years ago the professors in the colleges and all other learned men of the time were looking for three impossible things. They were trying to find out by the stars what would take place in times to come. This study led to our knowledge of astronomy.

They were trying to discover how to change common metals to gold. By their mixing and dissolving all kinds

of substances they built up the beginning of chemistry, and discovered many things about wine and spirits.

Above all things, men of eight hundred years ago were seekers for a substance which would make the old young again and prevent the young from growing old. They believed that there was really such a substance existing in the form of a very light spirit or gas. So they boiled substances in order to collect their gases. When wine was boiled they obtained a new substance which we know as alcohol.

A famous Arabian, named Albucasis, drank some of the alcoholic liquor which he had made and which was really brandy. He at once seemed to be a young and joyful man again. He told of his wonderful discovery, and by means of his so-called "water of life," he brought back the joys of youth to other old men. They soon discovered their mistake, but found themselves enslaved by the habit of taking the poisonous liquor. Soon all, including Albucasis himself, died from the effects of the strong drink. Before their time men had become drunk and had died from the effects of wine; but the effects of the distilled liquor were far more rapid and deadly than anything which they had known before. To-day men drink as much brandy and whisky as they do wine.

Within the last few years men have found out how to make strong drink quickly and cheaply. To do this, however, they must either add poisons or else neglect to remove some which are always found in new liquor. Yet no one can tell the poor liquor from that which is old and pure. Any strong drink is poisonous; but much of the cheap liquor to-day is as much more dangerous than the whisky of fifty years ago as that was more poisonous than the wine of old.

SUMMARY

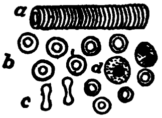
1. Alcohol is made from sugar by the growth of the yeast plant. In the body it needs no digestion, but it hinders the digestion of other things. It enters the blood at once, but quickly disappears again.
2. The use of alcohol tends to make men drink even when they feel that it will harm them.
3. Its oxidation uses up oxygen, so that too little is left for the albumin, sugar, and fat. Half-burned and poisonous substances are produced by their oxidation like the gases from a smoking lamp.
4. These poisons and the lack of oxidation in the cells of the body weaken the cells.
5. Alcohol makes the liver smaller and harder.
6. The three different kinds of alcoholic drinks are wine, beer, and distilled liquors.
7. All fermented drinks contain alcohol, and so are forms of strong drink.

CHAPTER VII

THE BLOOD AND ITS CIRCULATION

110. The blood. — After the food has been digested in the stomach and intestine and made into blood in the liver, it is sent to feed each cell of the body. About one thirteenth of a man's body is blood. This makes between five and six quarts.

The blood is a red liquid, but under a microscope it looks like clear water in which there float a great many round bodies. Most of these bodies are red, and are called *red blood cells* or *corpuscles*; a few are white, and are called *white blood cells* or *corpuscles*.



Blood corpuscles (× 400).
a a pile of red blood cells.
b red blood cells seen flatwise.
c red blood cells seen edgewise.
d white blood cells.

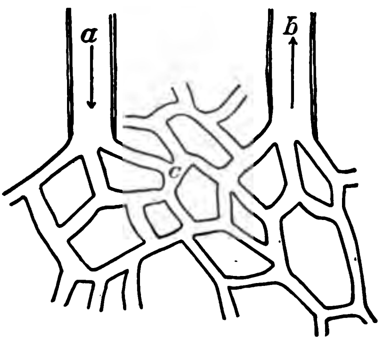
111. The blood cells. — Each red blood cell is a round, flat plate. It does not feed the cells of the body, but supplies them with oxygen from the air in the lungs. The red cells form nearly one half of the blood.

Each white blood cell is round like a ball. It moves with the blood, but it can move all by itself and live outside the blood. It is almost a living being in the blood, separate from the body. The white blood cells are only one three-hundredth as numerous as the red cells. They are always looking for weak or injured parts of the body, and when they find such a spot they leave the blood tubes and gather around it to mend

it. They also surround and destroy poisons which happen to get among the cells. We will speak of this later when we talk of inflammation and of catching cold. (See § 137.)

112. Plasma. — The liquid part of the blood is called *plasma*. It is water, in which a little albumin and mineral matters are dissolved. The albumin and the mineral matters are the real food of the cells.

When blood is drawn from the body, it soon becomes like jelly, or it *clots*, as we say. In clotting, some of the albumin of the plasma becomes hard like a boiled egg and makes the whole blood like jelly. Soon the clot begins to grow smaller and to squeeze out the liquid parts of the blood. Then the clot will float in a straw-colored liquid called *serum*. In a cut a clot reaches into the mouth of each blood tube and stops the opening, so that no more blood can flow. This is the way all bleeding is stopped.



Arrangement of capillaries.
a smallest artery.
b smallest vein.
c network of capillaries.

113. Arteries. — The blood is carried to the cells of the body through tubes which branch and divide again and again, until they reach every part of the body. The tubes which carry blood to the cells of the body are called *arteries*. Their sides are strong and tight, so that they cannot burst or leak. In them are muscles which can make them larger or smaller, so as to let the right amount of blood pass through for the use of the cells of the body.

114. Capillaries. — The end of each artery divides into a number of fine tubes called *capillaries*. The capillaries make a network so fine that they touch every cell of the body. The point of a needle cannot prick the skin without bursting some of the capillaries and so drawing blood. Each capillary has sides so thin and soft that the liquid parts of the blood easily soak through to reach the cells, and even the white blood cells burrow through its sides without harming the tube. The capillaries are only just large enough to let the blood cells pass through.

Diagram showing how food reaches the cells from the capillaries.

115. How to see the capillary circulation. — The web of a frog's foot is very thin and clear, and yet contains many capillaries. If it is spread out under a microscope, you can see the blood as it shoots through the tiny tubes. You cannot see the liquid part, for it is like water, but you will see the red blood cells, which, in the frog, are egg-shaped. They will pass through the larger tubes in a stream too rapidly for you to see the separate cells. In the smallest tubes, a cell may get stuck crosswise for a moment and stop up the whole tube, but it soon becomes free again and passes on. Sometimes a cell starts to go through, when a little movement of the leg will press it back again. You should get your teacher or some physician to show you this circulation. This will help you to remember that miilions of these tiny streams are continually flowing through every part of your body.

116. Veins. — The capillaries come together again and form tubes called *veins*. Each vein is a tube much like an artery. It carries blood away from the cells. It has valves which permit blood to flow toward the heart but keep it from flowing back to the cells. Each vein runs by the side of the artery which brought the blood to it. So the blood tubes are like a net hanging from two ropes. One rope is an artery, the net is the capillaries, and the other rope is the vein. The blood is always moving in the tubes. We must find out what moves it.

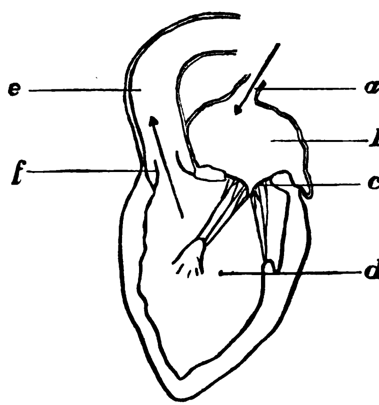


Diagram of the heart while it is beating.

a vein entering the auricle.
b auricle.
c closed valve to keep blood from flowing back into the auricle.
d ventricle.
e artery.
f valve to keep blood from returning to the ventricle.

117. The heart. — If we follow the arteries back, we shall see that they unite and grow larger until we reach a single tube nearly an inch through. This artery is called the *aorta*. At the beginning of the aorta is a pump called the *heart*. The heart lies just to the left of the middle of the body, and just below the level of the armpits. It is a bag about the size of the fist. Its inside is divided so as to make two bags. Each bag is a complete pump. The lower part of each side of the heart is called a *ventricle*, and the upper part an *auricle*. There are two openings in each ventricle. A hole in its upper part leads to the auricle. It can be closed

tightly by two curtains. A hole in its side opens into an artery.

When the ventricle is full of blood, all at once it becomes smaller and squeezes the blood. The pressure closes the opening to the auricle and keeps the blood from going out that way, and so it passes into the artery. Three little curtains keep it from running back into the ventricles. The heart keeps the arteries full of blood, and presses it through their branches and through the capillaries and veins. It finally reaches the heart again and flows into the auricles. Then it flows into the ventricles again, ready for another round of the body.

The sides of the auricles are thin, for they are made only to hold the returning blood while the ventricles are squeezing blood into the arteries.

118. Why the heart is double. — The left part of the heart sends blood to all parts of the body to nourish its cells. The right half of the heart sends the blood only to the lungs. There the blood gets air, which it carries to the cells. Food is gathered from the intestine by blood which is pumped by the left half of the heart, but in man only the right half of the heart sends blood to get air. A fish has only one auricle and one ventricle, which send blood to get both air and food.

119. Course of the circulation. — The left half of the heart sends blood through the arteries to all parts of the body. They empty it into the capillaries. Here some of the plasma and air go out to feed the cells. The rest of the blood then enters the veins, which bring it back to the heart, where it enters the right auricle and ventricle. They send it to the lungs to get air. Then it returns to the left auricle and ventricle ready for another round of the body. It takes twenty seconds to send a drop of

blood through the left ventricle, then through the arteries, capillaries and veins, and then to the lungs and back to the left ventricle. All the blood in the body passes through the heart every two minutes.

120. Venous and arterial blood. — In the lungs the blood from the veins becomes of a brighter red color. It goes back to the heart and is sent out again by the arteries. The blood going to the cells of the body is of a bright red color and is called *arterial* blood. The blood as it comes from the cells is darker in color and is called *venous* blood. Venous blood is not *bad* blood, but the change is due merely to the decrease in the amount of air in the blood.

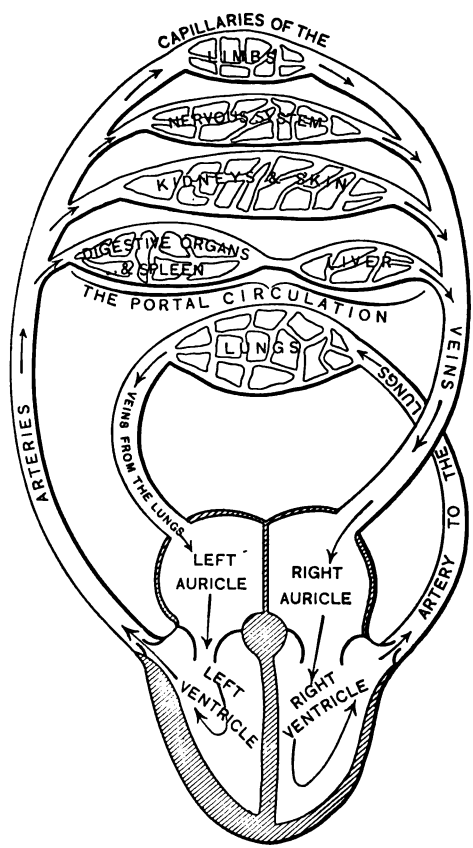


Diagram of the course of the blood in the circulation.

121. The heart beats and pulse. — While the heart is squeezing the blood, it can be felt through the sides of the body; this is called a *heart beat*. Each heart beat makes a wave of blood in the artery which can be felt when the artery is near the skin. This wave is called a *pulse* and is best felt in the wrist. The heart beats about seventy-five times each minute. Running or other work of any kind makes it beat faster, so as to send more blood to the cells which are working.

122. How cells eat. — Let us learn exactly how the cells of the body eat. We have seen how albumin and mineral matters soak through the sides of the capillaries along with the liquid parts of the blood, so as to reach the cells of the body. Each cell is thus bathed in food, and eats by soaking it in from all sides. So each cell is like the ameba, but with these differences:

First. The ameba must seek, catch, and digest its food, while the cells of the body are always soaked in food ready for their instant use. A few cells of the body in the stomach, the liver, the heart, and the blood tubes do all the work of making the food ready for the rest of the cells.

Secondly. The ameba can move about, while the only cells of the body which can move about are the white blood cells. The rest are held in place by little strings called *connective tissue*.

Thirdly. The ameba does just what it wants to, while the cells of the body each have one kind of work to do and must obey the orders of the mind in doing it.

Besides eating, each cell takes air from the blood and gives off carbonic acid gas and water and other waste matter from every side. Thus each cell breathes. We shall see how it breathes when we study the lungs.

123. The lymph. — The cells cannot eat all the plasma

which soaks through the capillaries, and so some always surrounds the cells. White blood cells also go through the sides of the capillaries and live between the cells of the body. Each cell also gives off waste matter. The mixture of these matters makes a fluid called *lymph*, which is always bathing the cells. Lymph is thin blood without its red cells. Only a little lymph can go back to the capillaries; so to take away the rest there is another set of tubes called *lymphatics*.

124. Lymphatics. — Each lymphatic is like a small capillary with thin walls. It begins in spaces between the cells and carries away the lymph, just as a pump driven deep into the wet earth brings up water. The smaller lymphatics unite to form about twenty fine tubes for each limb. They are too small and thin to be easily seen. They run up the limb, and at the backbone join together to form a single tube about the size of a quill. This tube is called the *thoracic duct*. It opens into a large vein in the neck. Thus the matters which leak out of the capillaries return to the blood in a roundabout way. Digested fat also reaches the blood through the lymphatics. The lymphatics are really a third set of blood tubes.

125. Lymph nodes. — Here and there the lymphatics pass through little bodies like grains of wheat or corn. They can be felt under the lower jaw and in the groin, and are called *lymph nodes*. Each node is like a sponge filled with white blood cells. As the lymph flows through the nodes they strain out and keep back poisons and waste matters which the white blood cells eat and destroy. So these nodes protect the body against poisoning. In some diseases they get so full of poison that they become swollen, red, and painful. In scrofula the nodes in the neck often form large swellings from this cause.

126. Regulation of the flow of blood. — When a cell is working hard, it needs more food than when it is still. Nature provides more food for a working part in two ways:

First. The muscles in the arteries relax, so that the tubes become larger. Then more blood flows through the part. When you run, your face looks red from this cause.

Second. The heart itself beats faster and with greater strength. After a race you can feel your heart beat within your chest. In these two ways nature always provides the exact amount of food which each part needs.

127. Effects of too much exercise. — During severe work the heart works harder, so as to provide food for the cells. This soon wears out the heart, so that it cannot send enough blood even for light work. Boys can run or work as hard as they please for a minute or two at a time and will not be harmed. But they often try to see which one can run the farthest or lift the most. Then they may get very tired and may so weaken their hearts that they never recover.

128. Fainting. — When the heart beats with little force, or stops beating, the cells suffer at once. The brain suffers sooner than any other part. Then the mind stops acting, and the person is *faint.* His face is white, for it has no blood, and he is in a deep sleep.

When a person faints, lay him down with his head low, so that blood will go to the brain. Rub his arms and legs towards his body to drive the blood to his heart. Also throw cold water on his face to cause the heart to beat harder. In a moment or two he will revive and be as well as before.

129. Alcohol and blood. — Alcohol hinders the digestion of food and weakens the liver so that it cannot change the food to blood as it should. Thus the blood carries too

little food to the cells. Men who drink become thin and weak. But beer drinkers take a great amount of water in the beer, and this makes them heavy and large. They look fat and healthy, but there is little strength in their flesh.

When alcohol takes oxygen from the body, the real food is half burned. The poisons which are produced remain in the blood and are carried to the cells and still further weaken them. So the drinking man can be injured by causes which would have no effect upon him if he did not drink. It is not true that alcohol helps any one to resist disease; the truth is that the drinker is very liable to become sick.

130. Alcohol and the arteries.—The oxidation of alcohol makes a large amount of heat suddenly. To get rid of it the muscles of the arteries suddenly loosen and let the tubes become larger. So more blood flows through to the capillaries. This happens in the skin more than anywhere else, and so more blood touches the air and the heat is lost. When the arteries have often been made larger, their muscles lose the power of acting, and so they remain too large permanently. After a while a drinker's face and nose are red all the time. If his flesh is cut, an extra amount of blood is needed to heal the cut; when the arteries cannot regulate the amount of blood, the cut heals slowly. If any part of the body is diseased, the extra quantity of blood cannot be sent to the part, and so it gets well slowly. During sickness or a surgical operation a drinker is always in greater danger of his life than he would have been if he had let drink alone.

131. Alcohol and the heart.—Alcohol acts as a stimulant, and compels the cells of the body to do more work; but gives them no extra strength with which to do it.

The heart is the most regular and the best behaved organ in the body, but alcohol makes it beat faster and harder than the body needs. So it tires itself out, and soon its beats become weaker. Thus a strong man weakens his heart instead of making it stronger. The cells of the heart's muscle, like the rest of the cells of the body, do not get proper food, and so they become still weaker. Alcohol gives a feeling of great strength to the body, but this is due to weakness of the brain, which does not feel fatigue as it should.

132. Tobacco. — Tobacco weakens and poisons all the cells of the body, but it affects the heart more than any other part. It causes the heart to beat more rapidly, and at the same time with less strength. Sometimes the heart beats slower than it should for a little while, and then becomes rapid again. Sometimes its beat can be too plainly felt. The result is that the smoker cannot work so hard as he once could. His heart beats with violence, but drives the blood with little force. He becomes very short of breath, because the blood does not circulate in the lungs as it should. When a young person's heart is injured by tobacco, there is great danger that it will stay weak all through life. Athletes, when training for a contest like running or rowing, do not smoke or chew, for they know that to do so would weaken their hearts and make them short-winded.

SUMMARY

1. The blood is a clear liquid containing albumin and minerals. In it there float many red cells and fewer white cells.
2. Tubes called *arteries* carry blood to all parts of the body.

3. Fine tubes called *capillaries* receive the blood and give it out to the cells.
4. Other tubes called *veins* carry the blood back to the heart.
5. The heart is a pump which keeps the blood in motion.
6. Each stroke of the heart makes a wave in the arteries, which we can feel as the pulse.
7. Cells eat the albumin and minerals which pass out of the capillaries, taking the food in by any part of their bodies.
8. The food which the cells do not use drains off in a set of tubes called *lymphatics*, which finally empty into a vein near the heart.
9. When a part needs more blood, the arteries become enlarged, and the heart pumps harder, so as to carry more to it.
10. Alcohol makes the arteries larger and causes the heart to beat quickly.
11. Tobacco poisons the muscle of the heart.

CHAPTER VIII

BLEEDING, WOUNDS, AND DISEASE GERMS

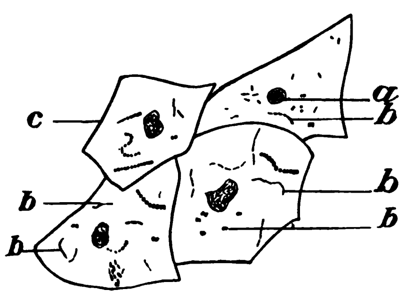
133. Bleeding. — When a person loses much blood, he feels weak and faint, and if one half the blood is lost, he dies. So bleeding is dangerous to life. We have seen how the blood clots and stops bleeding. When a large artery is cut, the force of the blood drives the clot out as fast as it forms, and so there is great danger of bleeding to death. Blood from a cut artery spurts out; blood from a cut vein only flows out, and does not spurt. So bleeding from an artery is far more dangerous than from a vein.

134. How to stop bleeding. — Every one should know how to stop bleeding. When dangerous bleeding occurs, just squeeze the sides of the wound tightly together with your hands. This is a sure and safe way of stopping any bleeding until some one comes who can help you. But sometimes a cut must be held for hours before enough clot is formed to stop bleeding. So while you are holding the cut you can get a handkerchief or any piece of cloth ready so as to tie it tightly over the cut, or just above it. Then a stick may be put under the handkerchief and twisted tightly, so as to close the bleeding artery. There is one important thing to remember: keep everything as clean as possible, and put no earth or cobwebs, or any other dirty thing upon the cut, for there is great danger of poisoning the wound by it. If bleeding comes from the arm or leg, very much less blood will go to the limb if

the person lies down and holds the limb straight up in the air. In nosebleed, the person should sit up so that the blood will not run to the head. If he presses the nostrils together and breathes through his mouth, the bleeding will soon stop. Then he should not blow the nose for some time, so that the clot may have time to get thick and surely stop the bleeding.

135. Injury to cells. — The cells of the body are always likely to be hurt, and yet they quickly mend themselves again. They are hurt by cuts, scratches, burns, and bruises. A blast of cold air upon a heated part of the body hurts the cells. But wounds are soon mended if we do not take cold in them. We must explain what taking cold is.

136. Bacteria of disease. — There are tiny living beings called *bacteria* which grow everywhere in dead matter. They produce decay, and change dead bodies to a form which plants can use as food. Without them, dead bodies would accumulate and cover the earth. But a few kinds can live in the lymph between the capillaries and the cells of the body, and there produce diseases. A few of these seeds or germs of disease are everywhere in the air, water, and soil, but there are very many in all kinds of dirt and filth. A pin point can carry thousands of these



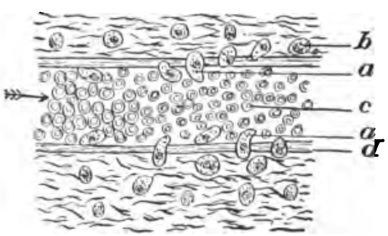
Bacteria growing in the mouth (× 400).

The specimen was obtained by scraping a healthy mouth.

a nucleus of an epithelial cell.
b different forms of bacteria.
c outline of an epithelial cell.

germs into the skin. They seldom grow in the blood, for it is in too rapid motion, but they do grow in the lymph and produce millions of new bacteria. They may fall upon a sore spot, or a cut, and so go into the lymph at once. These bacteria live upon the lymph and give out poisons which may make the whole body sick. Typhoid fever, diphtheria, cholera, and erysipelas are kinds of sickness caused by the bacteria. When a cut discharges matter, it is due to the same thing. The growth of these germs, and the effect of the poisons which they make, is what is usually meant by "taking cold."

Bacteria are always ready to enter the lymph, and the object of the physician and surgeon is to keep them out. When the germs are kept out, heat and cold and wet will not make a person take cold in a cut or wound of any kind.



Beginning of inflammation (× 400).

a white blood cells adhering to the wall of a capillary and passing through it.
b white blood cells which have passed outside of the capillary in order to repair an injury.
c white blood cells passing through the capillary.
d wall of capillary.

137. Inflammation. — Whenever the body is hurt, the first thing it does towards mending the wound is to loosen the muscles of the arteries going to the hurt spot, so as to let more blood go there. This makes the part *red.* Then the white blood cells begin to stick to the sides of the finest blood tubes and to pass through their sides into the lymph spaces. At the same time more of the watery parts of the blood leave the capillaries. This makes a *swelling*, while the pressure of the swelling upon the nerves gives

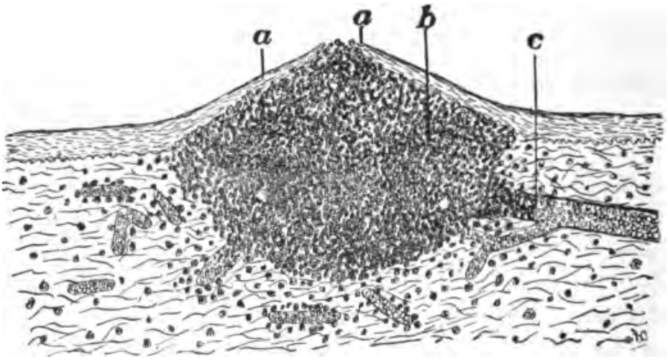
pain. The three signs, namely, redness, swelling, and pain, generally mean that a part is inflamed.

138. Repair of wounds. — The object of the increased quantity and action of the blood is to heal the injured part. If some of the cells of a part have been killed by an injury, the white blood cells eat up the dead parts and carry them off with the lymph. Some of the white blood cells become branched, and fit themselves into the spaces between the cells, and so become a part of the flesh. Thus the cut or injured parts are mended. The new flesh does not look like the old, but is puckered and firmer. It is called a *scar.*

139. Taking cold. — Now suppose bacteria are doing damage to the body, or get into the lymph spaces after it is done. Then they multiply and produce poisons which harm the body far more than the first injury. The white blood cells fight these bacteria. Whole armies of cells rush to the spot and usually soon overcome the germs. But many times the white blood cells are killed in the fight. Then others rush in, until they pack the lymph spaces tightly and fill the ends of the blood tubes and so cut off the supply of food. So the bacteria are besieged until they are starved to death, but the cells of the body also starve. Finally the germs, the white blood cells, and the cells of the body all die and soften and run out as *matter*, or *pus.* This is called a *gathering*, or *abscess.* A boil is an example of this. After the matter has run out, the white cells grow over the bottom and sides of the hole and soon mend it with a scar. So a few of the cells of the body give their lives in order that the rest may be saved. Those that were killed and formed the foul matter were just as good and strong cells as those that were left and healed the wound. They were not impurities in the blood,

but were its strongest and purest cells which went out to fight enemies and were killed. After they die, they decay and become poisons, and so must be thrown off.

The same thing happens in a cut. The bacteria grow upon its surface, while the white blood cells fight them until they are killed and flow away as matter. If the cut



An abcess (× 50).

a epithelium of the skin, softened and bursting.
b white blood cells which have packed the tissues full and shut out nourishment.
c blood tube stopped by white blood cells.

is kept closed and clean so that the germs cannot get in, there will be no cold in the cut, but the white blood cells will devote all their energies to mending the cut. Then the cut will heal in a few days, without pain or much inflammation.

When you sit in a cold wind after being heated by exercise, the tender cells of your nose and mouth are hurt, and you have a sore throat. Perhaps some bacteria grow there too. Then white blood cells and liquid parts of the blood pass out of the capillaries and form the thick matter which we spit out. This does not consist of impurities of the

blood, but it is what your body is using to mend the hurt and to destroy the bacteria. We insult these little cells when we call them impurities, while they are keeping off enemies and yet mending the wound too.

140. The skin in healing. — While the white blood cells are growing and healing a cut, the cells upon the surface of the skin around the edge of the sore slowly spread over it. This forms a new skin and ends the healing. This new growth of skin is necessary in every healing process. When the new flesh grows faster than the skin, the skin cannot keep up with it, and so the flesh forms a soft red tuft above the skin. This is called *proud flesh*, and must be burned or scraped off before the skin can finish healing the cut.

141. How to care for a cut. — Bacteria are everywhere, and readily enter a cut unless they are kept out. The surgeon keeps them out by wrapping wounds in cloths which have been boiled or steamed in order to kill the germs. He also puts on for the same purpose such things as carbolic acid. In this way he can keep the germs from the wounds which he makes, and so the white blood cells will have nothing to do except to mend the wound. Then in a few days even the largest cut grows together and is whole again.

When you cut yourself, the wound will soon heal if you bind it up with a clean cloth and change this often enough to keep the wound dry. Then no germs will grow in the cut, and nothing will prevent it from healing. It will be still better to put on the dressings something which will kill the disease germs. One part of carbolic acid in fifty of water is good. Friars' balsam is good, too. Do not put on a sticky salve, for it keeps in the disease germs and matter.

142. Catching diseases. — Some diseases, like measles, smallpox, and typhoid fever are caught from other cases of the same disease. These diseases are caused by some germ which can live in the air or soil after it passes off from the sick person. One may get these diseases by breathing the air of a sick room, or by eating some of the germs which stick to the hands or clothes, or by drinking some well water into which slops from the house have trickled. So great care must always be taken of a person sick with a catching disease.

In the first place, a sick room needs plenty of air, even in cold weather. This drives out the disease germs as fast as they form. Sunlight also kills the germs. So it is almost impossible to catch a disease in the open air.

In the second place, the sick room must be kept clean. The bedclothes must be changed often and washed, and the person himself must be bathed often. This also removes disease germs.

In the third place, soiled clothing must be boiled to kill the germs, or else they will carry the disease. Slops must be buried, or else have carbolic acid or some such substance poured over them to kill the disease germs.

In the fourth place, you must avoid handling the patient or his dirty clothes. When you come from the sick room you must not eat without washing your hands. You must not put your hands or fingers to your mouth in the sick room.

143. Effects of alcohol. — Since alcohol starves and poisons the cells, the white blood cells suffer with the rest, and are not able to fight bacteria or to repair injuries as they should. So inflammation is more likely to take place. A drinker is more likely to get pneumonia or consumption or other disease of the lungs. Alcohol scalds the throat,

and makes it tender and more likely to take cold. Thus the voice of the drinker is often so hoarse that he is unable to sing or talk. Far from protecting against disease or taking cold, alcohol causes a person to be more liable to sickness.

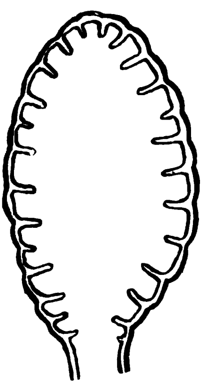
SUMMARY

1. You can stop any bleeding by grasping the part and making firm pressure.
2. When a part of the body is injured, it soon repairs itself.
3. Disease germs, called bacteria, can grow in the body. A pin prick may carry thousands of them inside the body.
4. Bacteria grow in the lymph, and produce such diseases as erysipelas and typhoid fever.
5. When a part of the body is hurt, the white blood cells rush to the spot and grow in place of the dead cells, and so heal the wound.
6. When germs of disease grow in the body, the white blood cells attack them. Matter which runs from a wound is made up of the cells which the disease germs have killed.
7. Taking cold means that bacteria are growing in some part of the body.
8. Cleanliness, to keep out bacteria, is the main thing in treating a cut.
9. Cleanliness, fresh air, and sunshine are the main things in caring for a sick room.

CHAPTER IX

RESPIRATION

144. Use of the breath. — The body is an engine, and its power is made by burning or oxidation. Every cell in the body must breathe in oxygen from the air, but only a few on the surface have access to it. So a few cells are set apart for the work of carrying it to the rest. Air is always going in and out of the nose or mouth. When we stop breathing for only a few seconds, we feel short of breath, and if we should stop for a few minutes, we should die. Air, then, is the most needful thing which we take into our bodies.

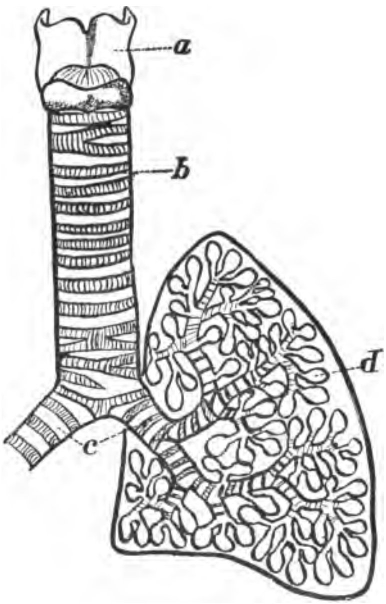


A frog's lung (× 4).

145. The air passages and the lungs. — The nose opens into the pharynx, which is just back of the mouth. From the pharynx there is an opening into the *windpipe.* The windpipe is a tube about six inches long. It branches into two tubes called *bronchi*, one for each side of the body. Each bronchus divides like the branches of a tree. At the ends of the smallest twigs are tiny bags or sacs, with very thin sides. The sacs can be blown up with air. The bronchi and air sacs make up the *lungs.* The lungs are light red flesh, much like a sponge. The air in them crackles when they are squeezed.

Look at the lungs of a pig or calf in the butcher's shop, for they are like a man's lung. A frog's lung is a thin bag, about half an inch in diameter. Upon its sides are shallow cups like the pockets of a honeycomb. Each air sac of a man's lung is like a very small frog's lung.

146. Breathing. — The lungs are hung in a box called the *chest* or *thorax*. The sides of the chest are the ribs, and its bottom is a leaf of muscle called the *diaphragm*, which stretches like an arch across the inside of the body. (See page 22.) The ribs and diaphragm can be moved so as to make the chest larger or smaller. When it becomes larger, the air is sucked into the lungs and makes them larger. This is called *inspiration*. When the chest is made smaller, air is driven out of the lungs. This is called *expiration*. This takes place about eighteen times a minute, but when you run or work hard you must breathe more often.

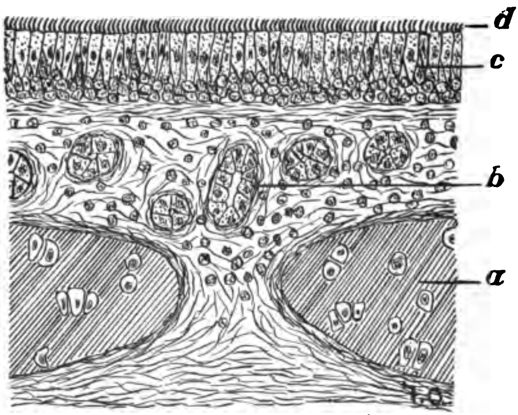


The air tubes and lungs.

a larynx or voice box.
b trachea or windpipe.
c bronchi.
d air sacs, each like a tiny frog's lung.

147. Cilia. — The lining of the windpipe and bronchi is made of cells whose inner ends are covered with tiny hairs

always in motion. The hairs vibrate in such a way as to drive anything out of the air passages. In the finest bronchi they reach a considerable way across the tube and entangle any dust which may reach them. So they protect the delicate air sacs from dust. They also force mucus towards the mouth, so that we can get rid of it



A slice from the trachea (× 200).

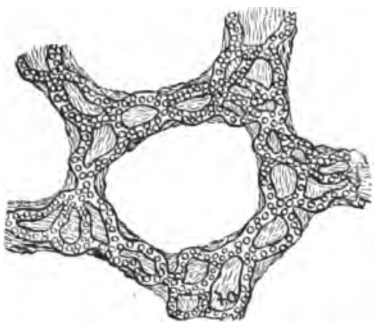
a cartilage. *b* glands in the mucous membrane.
c lining of epithelial cells.
d cilia upon the surface of the epithelium.

when we have a cold. Finally, the cilia make air currents in the tiny air tubes, and so hasten the exchange of pure for impure air.

148. Breathing sounds. — As air goes in and out of the lungs, it makes a low, blowing sound. Listen to each other's chests while breathing deeply and notice these sounds of breathing. Listen, also, while a person counts three. You will feel the chest tremble and hear the voice through the chest. The physician listens to the chest when he thinks a person has lung disease. By the

changes in the sounds he can tell what is the matter with the lungs.

149. What air does to the blood. — The air is four fifths nitrogen and one fifth oxygen gas. Both gases go into the air sacs of the lungs, but all the nitrogen comes back, while some of the oxygen is left behind, and some carbonic acid gas and water are put in its place. We must see what becomes of the oxygen. Upon the sides of the air sacs is a close network of capillary blood tubes. Their sides are very thin. While they keep the blood from running out, they let oxygen gas pass through very easily. The red blood cells are oxygen carriers, and as they shoot through the capillaries they take tiny loads of oxygen and carry it to all parts of the body for the use of the cells. Each load of oxygen causes its red blood cell to become bright red in color, and so the whole blood becomes a brighter red as it passes through the lungs.



Capillaries upon the sides of an air sac (× 200).

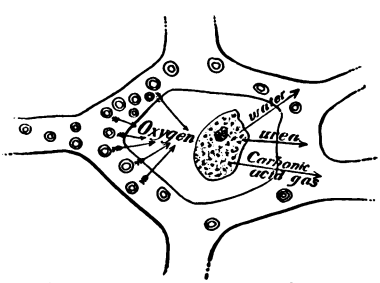


Diagram of the respiration of cells.

150. How air reaches the cells of the body. — From the lungs the blood goes to the left side of the heart and is sent through the capillaries to all parts of the body.

Not even oxygen can pass through the sides of the arteries, but when it reaches the capillaries it passes out very easily. So in the capillaries it leaves the red blood cells and goes to the cells of the body. When oxygen has left the blood cells, they become of a darker color. So blood in the veins is always of a darker color than blood in the arteries.

151. Oxidation in the cells. — The oxygen which goes to the cells of the body burns, or oxidizes, their albumin, fat, and sugar, producing carbonic acid gas and water. All oxidation inside the body takes place in a living cell. Oxidation is the real act of breathing. The cells of the body are always getting oxygen and giving out carbonic acid gas and water. The water drains off by the lymph. The carbonic acid gas goes through the sides of the capillaries and so back to the blood, where it is dissolved and carried to the lungs. So blood in the veins has less oxygen and more carbonic acid gas than blood in the arteries. It is the lack of oxygen, not the presence of carbonic acid gas, that makes the venous blood dark in color.

152. How carbonic acid gas leaves the body. — All the venous blood flows into the right side of the heart and is pumped to the lungs. In the lungs the carbonic acid gas leaves the blood and passes off through the sides of the capillaries into the air sacs. It is then breathed out by the next breath. At the same time, oxygen passes to the red blood cells again, and the blood is ready for another round of the body. So the blood carries oxygen to the cells of the body and gets carbonic acid gas from them, and then goes to the lungs to give up the carbonic acid gas in exchange for oxygen from the air. The real breathing in the body is done in the capillaries and cells. The lungs are places where the red blood cells get oxygen to carry to the cells.

153. How rapidly oxygen is used. — When the draft of a stove is closed, the fire stops burning at once. Just so the oxidation in the body stops when we stop breathing. In a lung full of air there is enough oxygen to last from one half to one minute. After that we feel very short of breath and cannot keep ourselves from breathing. A frog can take a big mouthful of air which will last him some time while he is under water, but finally he must come to the top for more air. A man cannot store air in his body, and so must keep taking in air every moment. The oxygen goes quickly to the cells, and starts the oxidation at once. A few deep breaths will relieve almost any shortness of breath.

154. Why we get short of breath. — When we run or work hard, our cells use a great deal of oxygen. Then we breathe deeper and take in more oxygen. But after a while the red blood cells have all they can carry. Then we cannot get more, but feel very short of breath. So we stop work until we have sufficient oxygen again. By training, we can educate the heart and lungs so that more oxygen may be carried. Then we can run a long distance without getting out of breath.

155. Mouth breathing. — You should always breathe through the nose. This warms the air and strains out its dust. When you breathe through the mouth, the cold air and dust make you cough and are very likely to give you a cold.

Some children have masses of flesh growing either in the throat, pharynx, or the nose. Such children always keep their mouths open, for they cannot breathe through the nose. The upper lip seems too short for their teeth. The jaw is narrow and the teeth point forward. This deforms the face for life. If these masses are removed

early, as can be easily and painlessly done, the jaw will grow into proper shape, and allow the child to breathe through its nose and become well again.

Many children breathe through the mouth from habit. They should keep from it even when they feel short of breath.

Another reason why a child should not breathe through the mouth is that it may produce earache.

156. Deep breathing. — The larger your lungs are, the more air you can take in. So you ought to take a deep breath several times a day. Then hold your breath as long as possible. In this way you will increase the size of your lungs and become able to run a long distance. It will also make you stronger all over, and be a great protection against your taking diseases.

A man should be able to make his chest two inches larger around with each breath. Three or four inches will be better. The more you can expand your lungs, the longer-winded you will be.

157. Position of the body. — You should always keep your shoulders thrown back and your chest forward, so as to give the lungs all the room you can. A round-shouldered, flat-chested man has little room for his lungs.

158. Tight clothing. — When your clothes are tight around the body, you cannot expand your lungs so much as you wish, and so you cannot run or work without getting out of breath. If you wear tight clothes day after day, your lungs will finally grow small and you will never be strong.

The waist should be large around so as to give room for the liver as well as the lungs. Girls need as much room for their livers and lungs as boys. They do a great deal of harm to themselves by making their waists small.

159. Artificial respiration. — We can breathe as we choose for a few moments, but nature finally makes us breathe as we should. Sometimes a person is injured in such a way that he cannot breathe. In drowning or an electric shock a person stops breathing. If he can only be made to breathe again, his life will be saved. Every one should know how to make a person breathe.

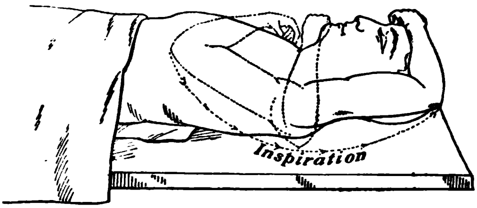


Diagram of artificial respiration, showing inspiration. The arrows show that the arms are moved outward from the sides of the chest.

When any one presses your chest or stomach, it drives the air out of your nose and makes a sound. In the same way you can make air pass in and out of a lifeless body by pressing upon the ribs. If you press as often as you yourself breathe, the body will get a large quantity of air. So if a person seems dead from drowning or electric shock, try to perform his breathing for him. You can do no harm and you may save his life.

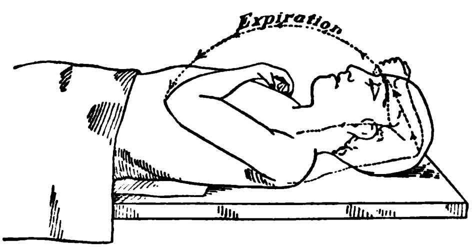


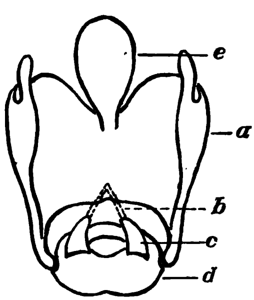
Diagram of artificial respiration, showing expiration. The arrows show that the arms are carried directly forward until they are pressed hard against the chest.

160. How to make a lifeless person breathe. — Here is a

good way to perform artificial respiration: Lay the person upon his back. Kneel down at his head and grasp his arms at his elbows. Now sweep them out from his body and bring them nearly together above his head. This expands the chest and draws air into the lungs.

Next, sweep the arms downwards and press them hard against his chest. This will force the air out of the lungs and will probably make a sound. Keep this up about as often as you breathe. You may need to keep doing it for an hour or two before a person revives.

161. Drowning. — In cases of drowning, the lungs will contain some water. Then you should turn the person upon his face and lift him by his chest so as to allow the water to drain out. Do this for a few seconds, and then keep on with the artificial respiration. Do not get hurried or excited. Remember that the life of the person may depend upon your causing slow and continuous breathing. Do not wait for help, but begin at once.

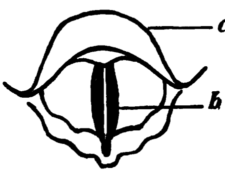


Back view of the larynx.

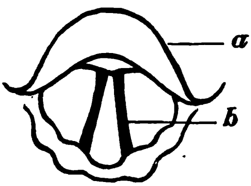
a thyroid cartilage.
b vocal cords.
c movable cartilage for the attachment of the vocal cords.
d cricoid cartilage.
e epiglottis.

162. The voice. — By means of the breath we talk, and laugh, and cry, and sing, and make all kinds of sounds to express our thoughts and feelings. Nearly all of these sounds are made in a little box called the *larynx*, in which the windpipe begins. Its outside can be felt in the upper part of the neck, under the chin, where it forms the *Adam's Apple*. Across the middle of the box two bands are stretched. These bands are called *vocal cords*. They slide sidewise and can be made either tight or loose.

When they are tightened and brought near together, and a breath of air is driven out through them, a noise is made. The sound varies with the tightness and the nearness together of the cords, and the force with which air is driven out. It is further changed by the mouth and nose, which act as a sounding box. In talking, the tongue and lips are moved so as to make different kinds of sounds. These sounds are so very much alike that the sounds of a foreigner's language seem the same, no matter what he is saying. Yet we learn to make the sounds with great exactness and rapidity, and to tell their difference easily.



Top view of the larynx, with the vocal cords closed, as in speaking.
a epiglottis. *b* vocal cords.



Top view of the larynx, with the vocal cords open, as in breathing.
a epiglottis. *b* vocal cords.

163. Care of the voice. — The larynx becomes tired, like any other part of the body. So it is harmful to strain the voice by loud shouting or singing. Breathing through the mouth is also harmful, especially if the air be cold or damp. Using the voice while the throat is sore is also harmful. Singing notes of very high pitch is also very tiresome to the voice.

It is easy to form the habit of talking in loud, coarse tones. Now the tones of the voice express our feelings. We ought to be careful always to speak in pleasant tones so as to make others feel happy even if we are not happy. Then we ourselves shall be more likely to be happy.

164. Alcohol and oxidation. — We have already studied

the process by which alcohol is carried to the liver, and there takes the oxygen which should go to oxidize the albumin, fat, and sugar of the body (see § 100). So when alcohol is used, not only the liver, but also all other cells of the body lack oxygen, and cannot work as they should. It should be remembered that alcohol is oxidized in the liver, and that none reaches the other cells of the body. Two or three drinks of whisky use as much oxygen as the whole body uses in an hour. So the cells of the body cannot breathe properly when strong drink is used.

165. Alcoholic breath. — When alcohol is swallowed, some remains in the throat and gives a bad odor to the breath. But it also hinders digestion and produces a coated tongue and biliousness. This gives a still worse odor to the breath. Alcohol itself does not go off by the breath, for it is oxidized in the liver.

166. Tobacco and the lungs. — The nicotine of tobacco has a sharp, peppery taste, and makes the throat tender and the voice hoarse. It hurts the nerves, so that there is a feeling as though something were stuck in the throat. Trying to cough it out strains the throat. By keeping the throat tender in this way a person makes himself more liable to take cold. Tobacco smoke in the windpipe and bronchi is still more harmful, for these parts are more tender than the throat. Instead, then, of making a singer's voice clear and strong, it makes it hoarse and weak.

Tobacco smoke has the same poisons as tobacco itself, besides other poisons developed by the burning. All these poisons in the smoke can enter the body. Cigarette smoke is drawn deeply into the lungs. Consequently it is more likely to remain in the body and poison the smoker. Of all forms of smoking, cigarette smoking is the most harmful. Yet many boys suppose it to be the least harmful form.

167. Adulterated tobacco. — Some cigars, cigarettes, and chewing tobacco have substances added to improve their taste. For this purpose, molasses, licorice, vanilla, and the like, are added. Some of these things do harm, and, in any case, the addition of such substances is a fraud.

SUMMARY

1. The lungs are made of tiny sacs, upon whose sides capillaries are spread.
2. By moving the chest walls, air is drawn into the lungs and forced out again.
3. As the red blood cells shoot through the capillaries of the lungs, they take up tiny loads of oxygen from the air. This makes the blood bright red in color.
4. The blood carries oxygen to the capillaries of the body. There the oxygen goes to the cells of the body.
5. The oxygen oxidizes the cells to carbonic acid gas and water. Thus the cells breathe.
6. The blood carries the carbonic acid gas to the lungs, and gives it out to the air.
7. When the cells have used all the air in the blood, we feel short of breath.
8. We should breathe deeply and through the nose. We should sit and stand straight, and wear loose clothes, to give our lungs room.
9. In a case of drowning, you can make air enter and leave the lungs by pulling the arms above the head and then pressing them against the chest. Do this as often as you yourself breathe.
10. Air passing between two cords in the larynx makes the sound of the voice.
11. Alcohol takes oxygen from the cells of the body.
12. Tobacco smoke irritates and poisons the lungs.

CHAPTER X

VENTILATION, HEAT, AND CLOTHING

168. Need of fresh air. — Since oxygen is taken from the air and carbonic acid gas goes out in its place, the air in a short time becomes unfit for use unless it is changed. Carbonic acid gas is but slightly poisonous in itself, or else the body would always be poisoned, but when it is breathed into the air the same amount of oxygen has been taken away from the air. Only a little oxygen can be taken away from the air before the body feels the loss. In a church, the windows are sometimes closed tightly and but little new oxygen can get in to take the place of that which is breathed. So there is not enough oxygen to keep up the full oxidation within our bodies. As a result, their power is lessened, and we become so sleepy that the best sermon does not keep us awake.

169. Foul air. — Water is always evaporating from the nose and mouth and going out by the breath. Odors from the mouth and clothes also enter the air. The moisture and odors are very unpleasant to sensitive persons and may of themselves cause sickness. Disease germs, such as those of measles and smallpox, are often given off by unclean persons. They are no more poisonous in a close room than out of doors, but in a room they are not scattered by the wind, and so another person is far more likely to breathe them in than he would be in the open air. So a

change of air is very necessary where people are together in a tight room.

170. Ventilation. — Changing the air of a room is called *ventilation.* In large buildings it is often done by fans and pumps, but in most buildings it is done by natural

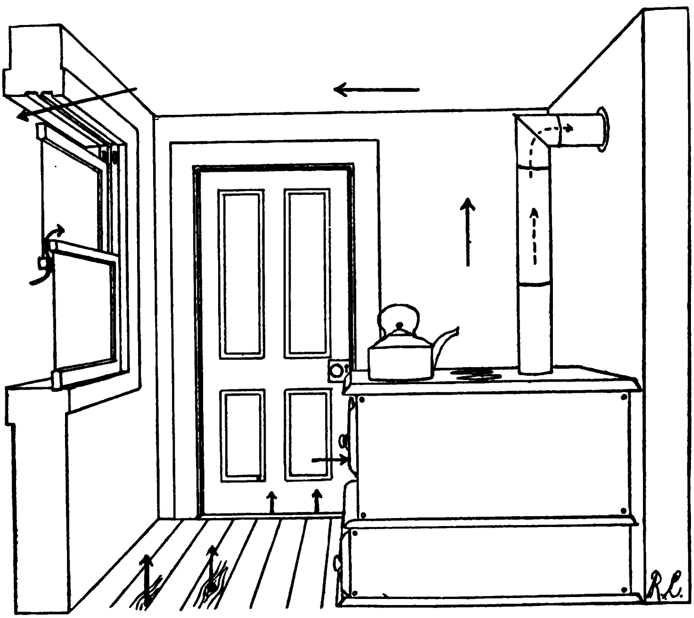


Diagram of the natural ventilation of a room.
The arrows indicate the direction of the air currents.

currents of air. Breathed air is warmed in the lungs. Warm air is lighter than cold air and so rises to the ceiling. If the upper part of the window is opened, the warmed air will pass out while the fresh air will enter by cracks in the doors and lower parts of the windows. On a cold day the difference between the warmed and cold air is very great. This causes a strong current; but on

a hot summer's day the breathed air is of about the same warmth as the air outside; so there will be no current unless the wind blows. This makes buildings very warm and close in the summer.

171. How to ventilate. — When only one or two people live in a room, the ventilation by cracks in the doors and windows is enough and in very cold weather may be too much. In new and very tightly built houses, the cracks are few and small, and more ventilation will be needed.

The simplest way to ventilate a room is to raise or lower a window. But then the cold fresh air may blow on some one's head and cause a cold. So you must be careful to open a window through which the wind will not blow. Another way is to raise the lower window sash and fit a board to fill the opening. Then the fresh air will come in between the two sashes and will make less of a draft.

Some houses are heated by hot-air registers. If the air in the register is pure, this will ventilate the room. Sometimes an opening is made in the chimney near the ceiling so that the impure air can get out; then more pure and warm air will come in. In large buildings like schools and theaters, there is often a fan run by machinery. This forces out the impure air and fills the room with pure air. So the air can be changed as fast as we wish.

172. Sick rooms. — It is very important to ventilate a sick room, for sick persons need all the oxygen they can get. They should not be disturbed with unpleasant odors. Especially in some kinds of sickness, disease germs need to be carried away as fast as they are given off.

173. Bedrooms. — *Night air* is exactly the same as air in the daytime, except that it is cooler. Sleeping rooms should be as freely opened to the air at night as in the daytime. The air of any room ought to be changed often

enough to prevent any odor in the room, for air that has no odor is generally pure and safe for use.

174. Warmth of the body. — Heat is produced by oxidation. This warms the whole body and also gives it power to think, and move, and work. Oxidation takes place in every cell of the body, but most of the fat is oxidized in the cells of the lungs, and most of the sugar in the cells of the liver. Muscle cells also produce a great deal of heat when they work. The body has the power of making its fires burn high or low as its work needs, but its own warmth always remains the same. A thermometer shows its temperature to be 98.5 degrees F., whether we feel warm or cold.

175. The feeling of heat and cold. — We sometimes feel very warm and again very cold, but our bodies always have the same degree of heat. We feel warmth mostly in the skin. So if the skin is warm, we feel warm all over, but if it is cold, we feel chilly all over. In fevers a sick person often feels very cold, for his skin may be cold while his body may really be in a hot fever.

176. How the body varies the heat. — When we work hard, we need a great deal more heat than when we are still. In winter we also need much heat to warm the body, while in summer we need but little. So we must vary the amount of heat. We can do this by varying our food. Fat makes a great deal of heat. So in winter we like fat meat. In summer we do not like fat so well, but prefer fruit. This has little fat, but a great deal of sugar, which produces less heat. In winter we eat more food than in summer. When we move about, we are warmer than when we keep still. So in winter we feel like working, for we need the heat of exercise to keep ourselves warm.

177. How the skin gives off heat. — The body has a

temperature of 98.5 degrees F. A room at this warmth would seem hot to us. Even 80 degrees F. is too warm. 70 degrees F. seems about right. This is only a little more than half way between freezing and the warmth of our body. So heat is always passing off from the skin and warming the air. We get rid of a great deal of heat in this way.

On a cold day the heat goes off faster than on a warm day. Then we should expect our bodies to be colder. But nature causes the blood tubes of the skin to become smaller so as to keep some of the blood away from the skin. Then no more than the right amount of heat will pass off, and we shall still feel warm.

On a warm day the heat will pass off from the skin more slowly. Then the blood tubes in the skin become larger, and bring more blood to the surface. Thus more heat can pass off, and the body will be kept at the right warmth.

178. How the perspiration affects our warmth. — A wet skin always feels cold, even if the water is warm when it is put on the skin. This is because the heat passes off in the steam as the water dries. The skin is always moist with sweat or perspiration. We cannot see it, for it passes off as fast as it comes out. But as it dries, it takes away a great deal of heat.

On cold days only a little perspiration is poured out, for enough heat will pass off without it. On warm days a great deal will often be produced, so that it may not dry so fast as it is formed. Then it collects in drops, and even runs down the face.

The perspiration enables us to endure great heat. Men have staid in hot ovens for some time without injury, for the perspiration carried the heat away from their bodies.

179. Fever. — When the body becomes too warm, we are in a *fever*, and are sick. If the temperature of the body is only one or two degrees too much, we do not feel well. A temperature of 105 degrees F. is a high fever, and is dangerous to life.

When we have a fever, we are very thirsty. Then we ought to drink cold water. This will help to lower the fever, and will also help to wash away the poison of the disease. It is also a good plan to bathe the body often for the sake of cooling it. Keep the room cool, and have little bed covering, for the sick person needs to be cooled, and he is in little danger of catching cold.

180. Sunstroke. — When exposed to a great heat under a hot sun or in a hot room, the body sometimes gets too warm. Then the person suddenly feels sick and faint. He is suffering from a *sunstroke*. This is a dangerous condition. It is most likely to occur on hot, damp days. On such days babies are very apt to become sick from the heat.

In sunstroke the person should be carried to a cool spot. Put cold water or ice to his head and body so as to cool him as soon as possible. He will need a long rest after he recovers.

181. Burns. — A temperature of 120 degrees F. is all the skin can endure. Above this the heat produces a smarting pain, and injures or kills the skin. If the heat is very great, the whole thickness of the skin may be burned.

When a person is burned, put cold water upon the burn at once, so as to stop the pain. Then put on some common baking soda, or some oil of any kind. A mixture of linseed oil and limewater is always good. This soothes the pain, and keeps the parts soft. Healing will take place slowly. Use the oil dressing until the burn has healed.

182. Burning clothing. — If the clothes catch fire, they are very likely to burn a person to death. The great danger is that the fire may be breathed into the nose and lungs. So a person whose clothes are on fire should lie down at once. This will also keep the flames from spreading over his whole body. If he now roll over and over, he will be very likely to smother the flames. At any rate, they will spread slowly, and will not reach his face.

If you see a person's clothes catch fire, at once throw him to the floor and roll him about. You can also wrap your coat or the carpet about him, and thus smother the flames.

183. Effects of cold. — When a person is exposed to very intense cold he becomes drowsy, and finally falls asleep. Then he is near death unless he is aroused. So when a person is very cold you must not let him rest, but keep him moving about.

When a part of the body, as a hand or an ear, is very cold, it becomes numb so that it cannot feel. Then we may think the part is warm, since we no longer feel the cold. But soon it may freeze.

Freezing is very apt to kill the part frozen. Rub it with snow, or place it in ice water and let it grow warm very gradually. If it is thawed quickly, it will surely die, but if it thaws slowly, it may finally get well, but it will be sore and will smart and itch for a long time.

184. Catching cold. — When one part of the body is colder than another, the blood is driven from the cold part and collects in other parts of the body. This disturbance is very apt to injure the cells and make us take cold. For this reason damp and cold feet are liable to cause sickness. We ought to wear thick-soled shoes or rubbers on every

wet day. We ought to be very careful how we cool our bodies when we are very warm. We are liable to catch cold if we go from a warm room into the cold air without putting on extra clothing.

185. Heating houses. — In cold weather we cannot keep warm without warming the air, so that less heat will pass off from the body. When houses were heated with open fireplaces, there was a roaring draft up the chimney with perfect ventilation, but the room was always cold only a little way from the fire. Now we use stoves. They do not use much air and so do not give much ventilation. If they give off dust and gas, they may make the air bad.

In many houses, a furnace in the cellar is used to send heat through pipes to all the rooms. This gives a great deal of ventilation and is a good way of heating. Steam in pipes is also used to heat houses. This heats the rooms well but does not afford any ventilation. When it is used we must be careful to let in enough fresh air.

Kerosene stoves, or other kinds of fire in which the smoke and burned products do not pass off through a chimney, are the worst ways of heating, for they not only use the air but they also pour foul gases into it.

186. The proper warmth of a room. — The best temperature for a house is about 70 degrees F. This feels neither too warm nor too cold. For a bedroom the temperature should be 60 degrees F. or less.

187. Clothing. — Sometimes nature cannot keep us warm enough in cold weather, or protect us from the heat of summer, and so men protect themselves with clothing. In cold weather our object is to keep the heat from passing off from the body, and we wrap ourselves in thick clothes. Clothing simply keeps in the heat of the body without adding any new heat.

188. Fur. — Fur lets the least heat pass off and so makes the best winter coat. The air between its separate fibers is a great help in keeping in the heat. When the fur is matted down, it lets more heat pass out and is not so warm.

189. Woolen. — Next to fur in warmth is woolen clothing. Soft cloth is warmer than hard or stiff cloth, for it holds more air. Silk is even better than wool to keep in the heat.

190. Cotton. — Cotton lets heat pass through it readily, and so is cold clothing. Linen lets heat pass through still more easily, and is still colder; but if enough cotton or linen is worn, it will keep in the heat, and so keep the body warm on a cold day. When linen or cotton underclothing is worn, a slight draft of air chills the body, for the underclothing does not keep in the heat, and so a person is liable to take cold.

191. How to clothe the body. — If a person wears woolen underclothing, little drafts of air have no effect in taking away the heat, and so he does not notice slight changes of the weather. In warm weather we wish to let the heat of the body pass off, and so we wear cotton or linen. Black cloth lets more of the sun's heat pass through it than white cloth, so white clothing is the cooler when we are exposed to the sun.

In winter we should wear woolen next to the skin so as not to feel sudden changes of temperature. Delicate persons should wear woolen all the year.

When we go from a warm room into the cold air we should put on an overcoat or wrap of some kind so as to avoid a sudden chill. When we work hard and become very warm we should not stop to rest without putting on our coat.

Lying upon the damp ground is dangerous, for it may make our clothes damp. This will cool one part of the body more than another and cause us to take cold.

Bundling the neck and ears while the legs and feet have no more covering than usual makes the head tender and often causes us to take cold. Then, since our feet are cold, we are almost certain to take cold. We had better cover the feet more warmly and not wrap up the head and neck.

We ought always to wear enough clothing to keep us warm. It is a mistake to think that we can get used to the cold by going without proper clothes. We shall be more liable to take cold and shall make ourselves more tender than ever. But we ought not to wear so much clothing that we are too warm.

192. Tight clothing. — The blood carries heat to all parts of the body. When the blood does not flow well through a part, that part becomes cold. If we wear tight garters or shoes, the blood cannot flow through the feet as it should. Then we have cold feet. Tight clothing of any kind makes us cold.

193. Paper clothing. — If paper were only stronger, it would make one of the best kinds of clothing. When we have too little clothing we can keep warm by putting a newspaper around the body under the coat or waistcoat. At night a few newspapers between the quilts will make us much warmer.

194. Cold-blooded animals. — Some animals, like frogs and snakes, breathe but little. They do not produce enough heat to make themselves much warmer than the air. On cold days they are dull and sluggish. In winter they are stiff and do not move, but lie buried in the mud or earth. Yet they breathe enough through their skins to

keep themselves alive. On hot summer days they are lively, for then they can form enough heat to keep themselves warm and have some left over with which to work.

195. Alcohol and warmth. — Heat is produced by the oxidation of alcohol. But it would be entirely wrong to think that it makes the body really warmer. The body does not like the heat which is produced in this way, but it at once tries to get rid of it by sending more blood through the arteries of the skin. This makes the skin warm and red, and the drinker says that he knows he is warmer because he feels so. His skin is really warmer, but this is because the heat is coming to the surface and is passing off. He loses more heat than he gains. Often his skin begins to perspire so as to get rid of still more heat. Men are deceived by this feeling of warmth more than by any other thing about alcohol, and some people who will not drink at any other time will drink before starting upon a cold ride. This is the worst time of all to drink. It brings the blood in contact with the cold air, and so more heat is lost. After the heat from the oxidation of the alcohol has passed off, the skin becomes cold once more, and the body feels colder than ever. But it was really colder all the time.

SUMMARY

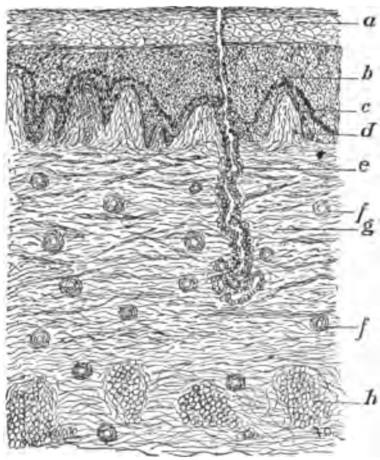
1. The air of inhabited rooms is continually being made foul by the breath and by vapors given off from the body. Its oxygen is also removed by breathing.
2. We must change the air of a room often enough to keep away all odors from the air.
3. Heat is produced by oxidation in the cells. This warms the body and also furnishes it with power to do work.

4. The skin gives off heat by contact with the cool air and by its perspiration.
5. Heat is always given off at such a rate as to keep the temperature of the body at 98½ degrees Fahrenheit.
6. When the body is too warm we have a fever and are sick.
7. The ordinary feelings of cold and warmth are due to the state of the nerves in the skin.
8. Burning or freezing a part kills the cells. Thaw a frozen part very slowly.
9. We should keep a room warmed to about 70 degrees Fahrenheit.
10. Clothing retains the heat of the body, but does not make new heat.
11. The oxidation of alcohol develops heat in the body, but it causes more to be given off through the skin than was produced.

CHAPTER XI

THE SKIN AND KIDNEYS

196. The derma. — The whole body is covered with a coat of woven cells called the *skin*. The skin of man is from one sixteenth to one eighth of an inch in thickness. It is made mostly of tough cells like strings, and contains more blood tubes and nerves than almost any other part of the body. This thick part is the true skin. It is called the *derma* or *cutis*. The derma of animals when tanned makes leather.



The skin (× 100).

a dead layer of epidermis.
b growing layer of epidermis.
c layer of cells containing the coloring matter of the skin.
d papilla.
e sweat gland.
f small blood tube.
g fibers of the derma.
h fat cells in the derma.

The nerves of the skin end in little pointed shoots of derma called *papillæ*. Rows of papillæ make the fine lines upon the palms of the hands. The derma is bound loosely to the muscles and deeper parts of the body so that it can move

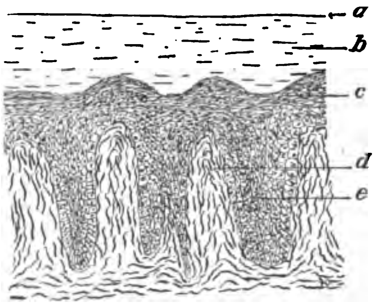
easily. It can be pinched up and stretched, but lies flat and smooth again as soon as it is set free.

197. The epidermis. — Upon the outside of the derma is a thin layer of scalelike cells called the *epidermis*. The cells are called *epithelium*. They resemble those which cover a mucous membrane (see p. 18). The epidermis has no blood tubes or nerves, and so can be cut or pricked without bleeding or giving pain. Its cells are formed upon the top of the derma and are soft at first, but as new ones grow, the older ones become hard and are finally shed or rubbed off. These hard scales protect the nerves and soft parts of the skin. Where the epidermis is gone and the nerves are touched directly, the part is very sore and tender. The papillæ reach into the epidermis so as to feel more easily.

Upon parts of the body which are rubbed, the epidermis grows thicker and harder, so as to protect the deeper parts better. This is called a *callus*. Rubbing the skin too hard hurts the deeper scales of the epidermis, and then water or blood collects under them and raises the epidermis into a little bag of fluid called a *blister*. In the deepest parts of the epidermis there are colored cells which give the skin its color. A negro is black only in a very thin layer of the deepest part of the epidermis, and his color is not even "skin deep."

198. Nails. — The cells of the epidermis at the end of each finger and toe are matted together to form a single thick and hard scale called a *nail*. The nails protect the flesh and form a kind of knife with which we can cut and make marks. They also can form a pair of pincers with which we pick up and hold small things. The cells of the nail are formed nearly as far back as the joint of the finger or toe. As new ones are formed the nail is

forced ahead, and so it grows long and needs to be cut off even with the ends of the fingers, with a sharp knife or scissors. When the nails are bitten off, they are left rough and are likely to catch in the clothing and tear away from the flesh. Biting the nails also makes the ends of the fingers soft and sore.



A nail (× 200).

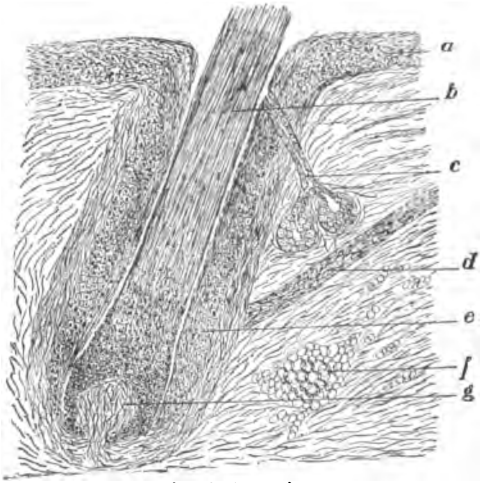
a surface of the nail.
b body of the nail.
c epithelial cells just before they are welded into a nail.
d papilla.
e growing epithelium.

199. Hangnails. — Sometimes a little tongue of skin at the root of the nail becomes torn up and hangs by one end. This is called a *hang-nail.* They are sometimes very sore, and biting them off makes them worse. They should be cut off close to the skin with a sharp knife. Sucking the fingers, or biting the nails, is likely to cause these hangnails.

Dirt under the ends of the finger nails is not only untidy, but may be poisonous. The nails themselves are not poisonous, but the filth which they carry may contain germs of sickness. So we ought to keep our nails clean.

200. Hair. — Little tubes of epithelium from the epidermis reach into the derma, and as fast as their cells grow they are matted together into a string called a *hair.* As new cells are always forming, the old ones are pushed out, and so the hair grows. When a hair is pulled out, the cells lining the tube keep on growing and soon make a new hair. Fine hair covers nearly all the body, but upon the head and upon men's faces, it grows long.

At the roots of the hair are the openings of small glands, which make an oily substance. This oils the hair and skin, and makes it soft and glossy. Each hair has a little muscle, which can pull upon the hair so as to make it stand straighter. Cold air makes the little muscles act, and pulls the hairs of the body straight up, so that their roots form little points above the flesh. We call these points *goose flesh.*



A hair (× 200).

a epidermis of the skin.
b hair shaft.
c sebaceous or oil gland.
d muscle which makes the hair erect.
e epithelium of the hair root.
f fat cells in the derma.
g papilla from which the hair grows.

201. Care of the hair. — The short hair of the body seems to be an aid in feeling. The hair of the head grows long for ornament and protection. A healthy person produces enough oily substance to keep the hair soft and glossy. If the hair is brushed so as to keep it clean and to spread the oil over it, it will look well without using hair oil or powder. On the other hand, most hair oils and restoratives contain substances which are harmful. Hair dyes are still more poisonous. They never make the hair look natural, and the lead which they often contain may poison the

body. The hair should be washed as often as it becomes dirty.

202. Perspiratory glands. — In almost every part of the skin there are little tubes made of cells of epithelium, like those of the epidermis. Their lower ends are coiled into a knot, and their outer ends open upon the surface of the epidermis. Each tube is a perspiratory gland. The cells of each gland make the *sweat* or *perspiration*. The perspiration is being given off all the time, and dries as fast as it forms. But if we are too warm, it is given off in such amounts that it collects in drops. About a quart is produced every day, and much more on a hot day.

203. The perspiration. — The perspiration is nearly all water. A little mineral matter and some oxidized waste matter are dissolved in it. You have already learned that the perspiration takes away the extra heat when we are too warm. This is the main use of the perspiration. It also takes away some waste matters of the body.

204. The waste of the body. — We will now study how these waste matters are given off. All oxidation within the body produces carbonic acid gas and water. The carbonic acid gas is of no use in the body, but passes off as waste through the lungs. A great deal of water must pass off from the body, so as to wash away the waste matter. Water is found in everything which the body gives off.

The oxidation of albumin produces, in addition to the water and carbonic acid gas, another substance which we call *urea*. Urea is a poisonous waste substance, and must be removed as fast as it is formed. If oxidation is incomplete from lack of oxygen or other causes, other substances like urea are formed. Many of these substances are extremely poisonous. Urea and all substances like it are given off by the perspiratory glands, and also by another

set of tubes called the *kidneys*. The waste mineral matter of the body also passes off by the skin and kidneys.

205. The kidneys. — The kidneys are two bean-shaped bodies, lying one on each side of the backbone, underneath the lowest ribs. Each kidney is made of coils of very fine tubes lined with epithelial cells. These cells separate the urea, mineral matters, and water from the blood, and pour the whole into a single tube which goes to the bladder.

206. Urea in the perspiration. — The perspiratory glands of the skin also separate urea, mineral matter, and water from the blood. The kidneys get rid of many times as much urea and mineral matters as the skin, but the skin gives off nearly as much water as the kidneys. Sometimes the kidneys get diseased, so that they cannot get rid of the urea. Then the whole body is poisoned, and the kind of disease called *Bright's disease* comes on. Then the skin may give off much more than its natural amount of urea, until the kidneys are able to do their work again.

207. Need of bathing. — The water of perspiration dries off from the skin and leaves the urea and mineral matters behind. The outside of the epithelium becomes dead, and part is worn off, and part stays upon the skin. All kinds of dust and dirt also stick to the skin, and stop its glands so that the waste matters cannot pass off as they should. So the skin needs to be bathed. Owing to the oil in the skin, water alone will not always remove the dirt, and so plenty of soap is needed. When there is an unpleasant odor about the skin, it certainly needs a bath.

In summer, when we perspire and the air is full of dust, we need a bath more often than in winter. It does not matter how the bath is taken, so long as we wash well. We can get clean by using a common basin. Bathing the

whole body every week in winter and two or three times a week in summer will keep most persons clean.

208. Too much washing. — Some persons soak themselves in hot water and rub the skin for a long while. Soaking in hot water loosens and kills the epidermis, and then by rubbing, it can be made into little rolls. These rolls are not dirt, but are the epithelium, which is a coat to keep us warm and to keep the deeper parts of the skin from being hurt. We can rub this epithelium off as long as any is left.

209. Cold baths. — A cold bath drives the blood away from the skin at first, but in a moment it comes back, and we feel warm again. The heart beats with greater vigor, and we feel refreshed by the bath. If we stay in too long, the blood does not come back to the skin and we feel cold and weak. A cold bath every morning upon first getting up makes us feel warm and refreshed. But a weak person cannot stand a cold bath. No one should stay in the water after he begins to feel cold.

210. Hot baths. — A hot bath causes more blood to flow through the skin, but does not make the heart stronger. Less blood passes through the brain and deeper parts of the body, and we feel weak and sleepy. Often we feel cold after it. The best time to take a hot bath is when we are going to bed.

211. A fair skin. — Bathing keeps the skin fair and smooth, but neither bathing nor anything else will make it fair if the waste matters which circulate in the blood are not given off in the right way. The best way to keep the skin fair is to arrange our food and habits so that there is only a small amount of waste matter to be given off. If we eat only plain food, slowly, and at mealtimes, and in the right amounts, our food will digest as it should, and

will be taken into the blood and be oxidized in the right way. Then the kidneys and skin will always do their work well. This is why you are so often told that you must keep your stomach in good order if you wish to have a fair skin. Paint and powder are merely a kind of dirt; they stop the action of the skin, and only make it look worse than ever.

212. Washing clothes. — The waste matters of the skin are rubbed off upon our clothes and bedclothes. These become dirty and must be washed. Air and the sun have great power of destroying waste matters of the body. At night all our clothes should be taken off and put where the air can get at them, and we should sleep in a clean night dress. In the daytime our beds should be aired, and the clothes and blinds opened so that the sunlight can reach the room and destroy the waste matter.

The water and waste matters of the body, and the water used in washing and bathing, all contain poisonous matter. If it is thrown upon the ground it may soak into the well and poison the drinking water, or its gases may make the air unfit for breathing. The water used by a person who has a catching disease is very dangerous, for the germs of the disease can grow outside the body and cause the disease in the next person who gets the germs. All water and slops ought to be carried away from the house and emptied into a deep hole in the ground. Then the soil will soon kill all the poisonous germs.

213. What to do with slops. — Small families in the country often throw their slops out of the back door, but it is not safe to do this, for some may run into the well and poison the water. A well ought to be dug on ground higher than the kitchen and barn. Hard rock or clay sloping toward the well may carry slops underground into the well

(see page 32). It is as dangerous to use such impure water for washing as for drinking. In cities the slops are carried away in pipes called *sewers*. They empty into the rivers or into the sea, and their waste matters are washed away. Sewers give off a foul gas, and great care is needed to prevent its getting into our houses.

214. Effects of alcohol upon the kidneys. — From the time alcohol is swallowed it causes more waste matters to be formed. It hinders digestion, so that the food does not reach the liver in the right form. The liver is overworked in changing the food to blood, and lets some through half changed, and even lets poisons pass through. Then, in the liver, alcohol appropriates oxygen and the food is not properly oxidized, but still more poisons are made. The kidneys and skin try to get rid of these poisons, and may do it for a long while, but they become overworked and finally fail, and then Bright's disease comes on. Alcohol makes more kidney trouble than all other causes put together; in fact, it is almost impossible to drink for a long time without bringing on kidney disease.

215. Alcohol and the skin. — Alcohol causes an increased flow of blood through the skin, making it redder than usual. After a few weeks of drinking, the skin and eyes remain red continuously, and their cells do not receive proper nourishment from the blood. These effects are seen upon the face more than anywhere else. Its skin is often rough or spotted, or covered with pimples. Often the nose becomes thicker and larger. All these things give the skin a very unpleasant appearance, but they indicate the condition of the whole body. A skin which is weakened by alcohol cannot do the work of the kidneys, and kidney disease in drinkers is much harder to cure than in those whose skins are in good order.

SUMMARY

1. The skin is made of a thick, tough part called the *derma*, and a thin protective covering of epithelium called the *epidermis*.
2. The derma contains blood tubes, nerves, and perspiratory glands.
3. The epidermis protects the derma and forms the nails and hair.
4. Oxidation of albumin makes a substance called *urea*, which must be given off from the body. Urea and carbonic acid gas are the main waste substances of the body.
5. The kidneys and perspiratory glands are coils of fine tubes, made of epithelial cells, which take water, urea, and mineral matters from the blood.
6. We must bathe our bodies and wash our clothes so as to wash away the waste matters from the skin.
7. Slops must be carried away from the house so that the poisonous matter will neither get into the well nor make foul gases.
8. Alcohol causes poisons to be formed in the body which the kidneys try to throw off, but they become overworked and diseased in the attempt.
9. Alcohol weakens the skin so it cannot help the kidneys get rid of the waste matter. It also gives the skin an unpleasant appearance.

CHAPTER XII

THE NERVES AND SPINAL CORD

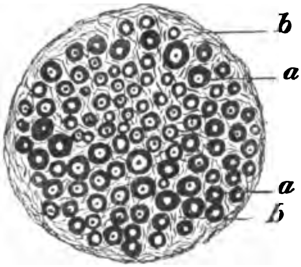
216. Cells act together. — We have seen that the cells of the body eat and breathe, and that oxygen burns their food and bodies, produces heat, and gives them power for their work. Each cell is thus a complete animal, like the ameba. But millions of amebas tied together in the shape of the body would not act like a man, for no two would act together, but they would fight and strive to get away from each other. The cells of the body are tied together by strings of connective tissue. But they are well-trained servants, and all obey the mind. They work so well together that we do not think of our bodies being made of separate cells.

217. Nerves. — The mind lives in a few cells and rules all the rest. From these cells, little threads called *nerves*

A nerve thread (× 400).
a central conducting fiber. *b* covering of fat.

go to every part of the body and touch every cell. The mind and the cells talk to each other over these threads, just as you can talk to a friend over the telephone. A nerve thread is like a very fine wire covered with a kind of fat. It is so small that a microscope is needed to see it. Many of these threads run together in bundles, which we

call *nerves*. In the upper part of the arm or leg they are as large as a knitting needle, and grow smaller as threads are given off to the cells. There are more of these nerves in the skin than in any other part of the body, but yet a thread reaches every cell of the body.



A thin slice from the end of a cut nerve (× 200).

a nerve thread.

b connective tissue binding the threads into a cord.

218. Motor nerve messages. — Nerves can carry messages both from the mind to the cells, and from the cells to the mind. The mind sends messages to the cells for each to do its own kind of work. Thus it tells the muscle cells to move the arm or leg. It tells the salivary glands to make saliva and pour it into the mouth. It tells the liver cells to change digested food to blood.

The mind also tells every cell in the body how much to eat, and how much oxygen to breathe. The cells can eat and breathe without being told by the mind, but if the nerves do not bring the messages from the brain, the cells do as they please about eating, and sometimes get lazy and hardly eat or breathe at all, but waste away as in a paralyzed man.

Nerves which carry messages from the brain to the cells are called *motor* nerves, for orders to move or change in shape are often sent to the cells. These messages are continually coming and going, and when they stop, life ends at once.

219. Sensory nerve messages. — The cells of the body also send messages of their state and needs. They send messages to the mind whenever anything touches them.

The message to the mind is called a *feeling* or *sensation*. The cells send such true news of everything which they touch that the mind depends upon it wholly for news of the outer world, and is seldom deceived. When something touches the cells so as to hurt them, the mind feels the message as a *pain*. Then the mind tells the muscle cells to pull the cells away from the thing which hurts them. Pain is a good thing, for it not only tells us when we are being harmed, but it also makes us get away from danger.

The cells of the body also send word when they are hungry or thirsty. This is different from the hunger and thirst which we feel in the mouth, and which is only the message of the stomach that it is empty. Each cell of the body calls for food, and the mind supplies it by causing the arteries to become larger so as to supply them with more blood. Each cell also sends word to the mind when it is tired and needs rest.

A nerve which carries messages to the brain is called a *sensory* nerve, because we feel many of the messages. We do not feel the message as it passes over the nerve, but only when it reaches the mind in the brain.

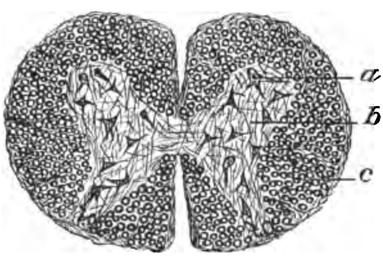
220. False messages. — Sometimes false messages are sent. If a nerve is pinched or hurt in its course, the mind feels the message as if it came from the end of the nerve. When we pinch the nerve which makes the funny bone in the elbow, it seems to the mind that the little finger is hurt. When the nerves at the knee are squeezed, as when you sit with your legs crossed for some time, they cannot carry the messages from the foot, and so we say that the foot is asleep.

When the surgeon cuts your flesh, you feel great pain. So he puts a little cocaine upon the nerve through a hollow needle. The cocaine keeps the nerves from sending the

news of the cut to the brain, and you do not feel pain when you are cut. In a little while the blood washes away the cocaine, and you can feel again.

221. How fast nerve messages travel. — The nerves can carry messages about one hundred feet each second, or a little faster than an express train. In the time between two ticks of a watch, news of a pin prick can travel from the foot to the brain, and the mind can send word back for the muscles to move the foot away from the pin. If your arm were long enough to touch the sun, you would die of old age before the feeling of the burn could reach you.

222. The spinal cord. — As we follow the nerves backward, we can trace them into the inside of the backbone, where they seem to come from a white string of flesh called the *spinal cord.*



A thin slice from the spinal cord with the cells and nerves magnified 200 diameters.

a cells in the gray matter.
b fibers in the gray matter.
c nerve threads in the white matter.

The spinal cord is a soft cord about eighteen inches long, and about the size of the end of the little finger. It is hung in the middle of the rings of bone which make up the backbone. When it is cut across, its end looks like a white ring around a gray, butterfly-shaped center. In the gray matter are cells in which a part of the mind lives. The white matter is made of nerve threads like those in the body. Some stop at the cells of the spinal cord; others go on to the brain; and still others start at the cells of the cord and end in the brain.

223. How the spinal cord acts. — The mind in the cells of the spinal cord is like a telegraph operator, who does not send messages except as others tell him to. In the first place, the mind in the brain sends all its orders through its servants, the cells of the spinal cord. When it wishes to move the hand, it sends word to the cells of the spinal cord, and they send word to the muscles of the arm so quickly that we do not know that they had anything to do with moving the arm.

224. Reflex acts. — In the second place, the spinal cord sends orders when asked to do so by the cells of the body.

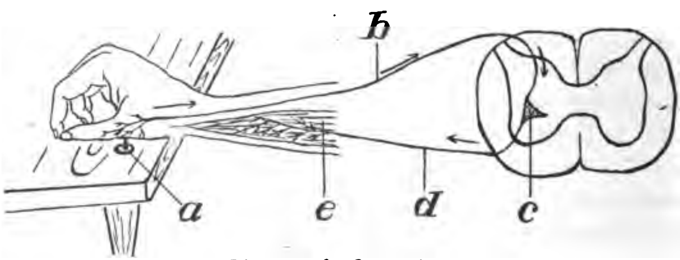


Diagram of reflex action.

a tack pricking the hand. *b* sensory nerve. *c* nerve cell in the spinal cord. *d* motor nerve. *e* muscle moving the hand away from the tack.

The nerves which carry the messages from the cells of the body go to the cells of the spinal cord, and also to the brain. The cells of the spinal cord are much nearer the cells of the body than the brain is, and when they get word that anything has harmed a part of the body, they have the power to order the muscles to snatch that part away without waiting for word from the brain. Thus, when the cord receives word that the hand touches a hot stove, it at once sends an order for the muscles to snatch the hand away, and it is done by the time the brain feels the burn. When anything suddenly hurts you, you cannot

help jumping away. This is called a *reflex* act, because the pain seems to be reflected back as motion.

225. Orders for the growth of cells. — The spinal cord also sends most of the orders for the cells to eat and grow, and for the glands to work, and for the arteries to become large or small, as each part of the body has need of blood. These are nearly all reflex acts. When the cells of the stomach feel food touching them, they tell the spinal cord, and it sends word to the glands to pour out gastric juice.

226. The sympathetic nervous system. — The spinal cord sends its orders for the growth of cells, for digestion, and for the flow of blood through a minor set of nerve cells and fibers. There are several small collections of nerve cells arranged mostly in a double row down the front of the backbone. Each collection looks like a grain of wheat and is called a *ganglion.* From the ganglia fine nerves go to the different arteries and glands, and to the stomach and intestine. The ganglia are also connected with the spinal cord and derive most of their power from it. They are really its servants, just as the cord itself is the servant of the brain. The ganglia and nerves are called the *sympathetic system.*

The sympathetic system sends its orders slowly and regularly. It has but little sensation, and is but slightly affected by outside influences. So ordinary causes will not disturb digestion or the flow of blood.

227. Acquired reflex acts. — In order that the brain may be able to do more work, it is continually teaching the spinal cord how to send the proper messages alone. When a baby first learns to walk, its brain has to tell the spinal cord just how far to order the feet to be moved, and when and in what direction. So it is hard and slow work for the baby to walk, but in a little while the spinal cord learns

to send the orders alone, and thus walking becomes a reflex act. So in learning any new motion, after we have done it a few times our spinal cords send the proper order without our thinking of it.

228. Need of the spinal cord. — The spinal cord acts without our knowledge. We do not feel the cells of the body grow, and we do not feel the spinal cord send the orders for their growth. It controls all the vital actions of life. It is well we do not have to think about sending the orders for living, for we might forget them and then we should die. As it is, the cord attends to them wholly without our knowledge. We put food into our stomachs and the spinal cord sees that it is made into living cells and that the cells do their work. We cannot change its work by any amount of thought or effort. An animal's spinal cord does its work as well as a man's. In fact, it has the same kind of work to do and is as perfect as man's.

SUMMARY

1. Nerves carry messages from the mind to the cells of the body, telling them to act and to eat. The cells also send messages to the mind, telling of their needs and of what is touching them.
2. Nerves begin in the spinal cord.
3. The spinal cord is itself made of nerve threads, and also of cells in which a part of the mind lives.
4. The nerve cells of the spinal cord send messages over the nerves when told by the mind in the brain.
5. The cells of the spinal cord also send orders in response to information brought by the nerves. This is called a *reflex action.* Orders to grow and to snatch the body from a sudden danger are reflex acts.

6. In sending orders for the preparation of food and the growth of cells, the spinal cord acts through another set of nerve cells and fibers called the sympathetic system.
7. The sympathetic system sends fine nerves to the muscles of the arteries and of the intestine. It acts under the control of the spinal cord.

CHAPTER XIII

THE BRAIN

229. The brain. — The mind, which is the real man, and which feels, thinks, and makes our bodies move, lives in the brain. The brain lies in the top of the head and is covered with the bones of the skull. It is a soft, white mass weighing about three pounds.

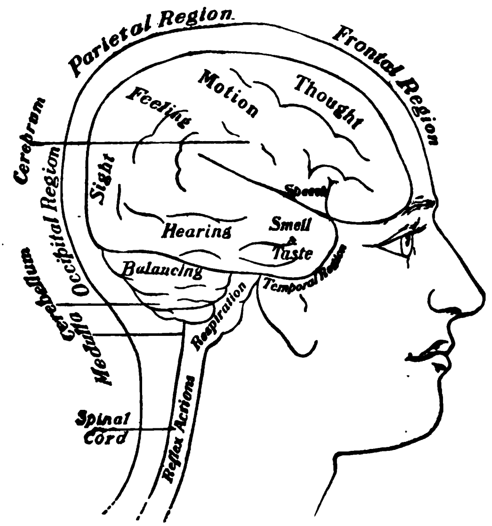
230. The medulla. — The brain is made of three main parts. Just above the spinal cord is a small, wedge-shaped part called the *medulla oblongata.* The medulla is a part of the spinal cord as well as of the brain. It gives off nerves to the head just as the spinal cord gives them to the rest of the body. In it is a little bundle of nerve cells which send out the orders for the body to breathe. When these cells are hurt, breathing stops at once and the body dies. So the medulla is often said to be the seat of life.

Human brain cut crosswise.

231. The cerebellum. — Above the medulla is a round part of the brain called the *cerebellum.* It neither sends orders nor feels, but in some unknown way it helps the rest of the brain so that they send out better orders for

walking and standing upright, and for all motions in which the body must make exact movements. A bird or dog without its cerebellum cannot run or stand, but flutters or rolls about the floor. Yet it is strong and acts all right in other ways.

232. The cerebrum. — The uppermost part of the brain is the *cerebrum*. It is about four times as large as all the



Regions of the head and action of the different parts of the brain.

rest together. Its inside is white matter and is made of nerve threads. Over the white matter is a covering of gray matter which looks as if it were too large and so is folded and puckered. The gray matter has many nerve cells. The mind lives in these nerve cells. The nerves of the white matter join these cells and connect them with the spinal cord and with the nerves of the body.

233. The senses. — The cells of the body are continually sending news of their own state to the spinal cord. The brain feels the news only when it is very great in amount, as when the body is hungry or thirsty or tired.

The cells also send messages telling what is affecting them from the outside. This news goes to the brain and produces a feeling, while it only slightly affects the spinal cord. We get news of the outside world by means of seeing, hearing, feeling, smelling, and tasting. These five kinds of news are called the *senses*.

234. Location of the senses. — Feelings of sight are brought to the cells of the brain under the lower and back part of the head. Messages of sound, smell, and taste reach the mind in the cells just above the ears. We feel a touch or pain by means of the cells under the top part of the head. This means that if the back part of the brain is injured, we can no longer see. In the same way, an injury to any part of the brain deprives us of the sense which is located there.

235. Motion. — Besides feeling, we can also move our bodies as we wish. The orders for moving are sent from the brain down the spinal cord, and out along the nerves, to the muscles. They cause the muscles to move the body. That part of the brain under the top of the head in front of the ears sends the orders for motion. If this part of the brain is hurt, we cannot move so much as a finger, even if we can feel and have a full knowledge of what touches it. Each muscle has its own set of cells in the brain. These do the same things in both man and animals.

236. Memory. — When a cell of the brain receives a message, it lays it away so that it can find it again. A message stored away for use is a *memory*. We remember

how pleased we felt when we heard the band play, and how our ears ached when we were out in the blizzard. We can also remember the messages which the brain has sent out. Thus we remember how hard we had to run to catch the train, and that we had to make our arms move in a certain way in order to throw a stone against a mark.

237. Association of cells. — Each cell in the brain is connected with all the other cells through the nerve threads of the white matter. So when we remember one thing we at once think of something else about it. Thus one set remembers that it saw a field of large ripe blackberries; another set of cells remembers how good these tasted; another set remembers hearing a dog make a great noise; and still another set of cells remembers how fast it made the legs run to take the body away from the berries.

238. Thinking. — The minds of all animals can feel as well as a man's mind, or better, and can often make their bodies move more swiftly and more gracefully than man's. But the mind can do more than feel and cause the body to move. It can think about what it remembers. It thinks that some things were right and some wrong, or that we could have done better if we had acted in a different way. It plans to do things better next time. An animal does very little thinking; so we say that it has no mind. It seldom plans ahead and does not learn new things easily. Yet some dogs and horses use almost as much thought as some men.

239. Where thinking is done. — Thinking is done by the cells of the brain behind the forehead. Animals have very small foreheads, and so their minds cannot think to any extent. While most of the cells of the brain can act from the time a child is born, the thinking cells must be taught how to act. Boys and girls go to school so as to

teach the cells of the forehead how to think. The cells of the rest of the brain may know how to feel and see and hear, and how to make the body move, and may have wonderful things stored in memory, but if the forehead cells do not know how to think, the mind cannot make use of the memories. We say that such a person is a fool, even though he has great knowledge. In school it is of little account how many things are stored away in the memory, for we can get memories anywhere. But in school we should learn how to use memories, and how to tell which ones are best and right for the work we wish to do.

240. How to think. — The only way to teach the cells under the forehead is to make them work at one thing at a time until they can do it. When a boy wants to get his lesson upon the reason for the temperature at the North Pole, he cannot do it if he thinks a minute of the North Pole, and then a minute about snowballing, and then another minute of baseball, and then goes at the North Pole again. But this is the way boys and girls naturally do, and only a few succeed in training their foreheads to think of one thing at a time. To learn to think well requires great effort, kept up for a long time. A man is educated when he can use all the power of his mind in thinking of one thing at a time. If a boy thinks of kites when he is studying geography, he must get back to his geography as quickly as he can. He will like his kites all the more when he gets his lesson, for he will be more likely to put his whole mind upon them.

241. Speech. — The highest act of the mind is *speech*. The lips and tongue can be moved when ordered by the brain cells above the ears, but if they move so as to produce speech, the orders must be sent by a special set of

nerves in the lower part of the brain just above and in front of the left ear. When this part of the brain is destroyed, a person cannot talk, but he can still make a noise with his mouth and understand speech, for the hearing part of his brain is whole. He can also read and write, for these parts of his brain are also whole.

242. Use of speech. — The power of speech accounts for the great difference between man and animals. Animals must learn everything through their senses. They cannot tell one another how to do certain things. They cannot tell their knowledge to their young.

Men know far more things than they have learned by their senses, for they can tell each other. In a short time the father can tell his child what it has taken him a lifetime to learn. Children of ten years of age now know much more about some things than men used to know a hundred years ago. Some persons cannot see or hear or speak. They learn with great difficulty, but finally they can be taught to read with their fingers and then they learn as rapidly as others.

243. Need of a healthy body. — Thinking is work, just as running or any other action of the cells of the body is work. In order to think, the cells must get plenty of food and oxygen. The cells of the brain are the first to suffer when food does not digest or the air is foul. A headache and dull feelings are the first signs that something is wrong with the food or air. Anything that makes food digest better, or that causes us to breathe in more oxygen, helps the brain. Plenty of out of door exercise is a great help to the scholar. The best student generally has a strong body.

244. Sleep. — The brain cells work and become tired like any other part of the body. They need rest. Some

must keep acting all the time. The spinal cord must keep sending orders to the cells to eat and grow, and the medulla must send orders for us to keep breathing. But they send an order and rest a second, and then send another. Like the heart, they rest half the time.

When the thought cells rest, we do not know anything, but are asleep. During sleep they regain strength and grow like a resting muscle.

245. Worry. — We can do a great amount of hard brain-work if we can only sleep. It is doubtful if any one can overwork the brain if he gets rest in sleep. He cannot help sleeping when his brain gets tired, and when he wakes he will be ready for work again. But sometimes a person is troubled. This keeps his mind in action just enough to prevent his resting. Then he feels tired, even if he does not work, for he gets no rest.

246. How much sleep? — A child needs at least ten hours of sleep each day up to the age of twelve years. By the time he is eighteen, he needs only eight hours. By the time he is thirty, six or seven hours of good sleep will be enough. When he becomes old and feeble, he will need more again.

The time of sleeping is of less importance than that this time should be regular. A short nap in the middle of the day is very helpful.

247. Habit. — When the cells of the brain have done a thing a few times, they want to do it again, and will often act without our knowledge. So we can form a habit of doing a thing. All of us have habits, and are forming new ones. We may swear, or drink, or be dishonest once or twice, and not be so again. But if the temptation comes again we shall yield more easily for having yielded once, and after a few times we shall yield even if we do not

want to. Many men swear when they do not know they are doing it. They have acquired the habit, and find it very hard to stop. We should be very careful how we begin to do a wrong thing, for no matter how strong a mind we have, we may fall into the habit of doing the thing.

248. Good habits. — We can also form good habits. If a boy is brought up to be generous and to speak kindly, he will find it easy to do so all his life. He will not think that giving means a loss to himself, but he will find as much pleasure in the joy of others as in his own happiness. We ought to form habits of doing good deeds and saying kind words. Then we shall be of benefit to all around us, and shall become useful and noble men and women.

249. Heredity. — Our habits affect others besides ourselves and our neighbors. They may become transmitted to our children. This transmission is called *heredity*. The son of a drunkard will be likely to drink, and the son of a thief to steal. The tendency is born in them. To get rid of it, such boys must be taught good habits from their babyhood. If they yield once, their tendency to form the bad habits of their fathers will be stronger than their tendency toward the good.

250. Nervousness. — A man's feelings often lead him to desire things which his thoughts tell him are wrong. Sometimes his feelings are made very unpleasant by little things which his reason tells him he should not mind. In all persons there is a conflict between thought and feeling. Man differs from the lower animals in that he puts aside his present feelings so that he may get more good in the future. Reason must often overrule the feelings, to deny them a pleasure or to compel them to endure an annoyance. A lack of self-control is *nervousness*.

Nervous persons are made uncomfortable by slight noises, or by little pains, or by being denied something that they want. They complain, and go about with sad and troubled faces, like spoiled children. They make more fuss over a slight thing than they would over the loss of a dear friend. They are generally afraid that something is going to happen.

Nervousness is to a great extent a habit. By an effort of thought any one can overcome nervousness. It is the duty of every one to do this. You should not laugh at a nervous person, but should encourage him in every way to become as brave as yourself.

251. Fear. — An extreme degree of nervousness over any one thing is *fear*. The great danger in fear is that a person may not think of what he is about. Then instead of escaping from danger he may rush into it. When a crowd is in danger, as in a burning building, all are liable to rush in one direction and to trample upon each other as they try to escape. Then a cool head is needed. Do not follow the crowd, for it is more dangerous than the fire. Remain quietly until you can get out without going in the crowd. You will be safer, and besides you will do a great deal towards making others in the crowd think of what they are doing.

252. Fire drills in schools. — In large school buildings, the children are trained to drop all work at the sound of a bell and to march quickly from the building. The bell is the fire alarm. It is sounded every day or two when the children are not expecting it. They do not know whether it is sounding a real alarm or not. When a fire really occurs, they will march out of the building as orderly as in the drill. The drill is a good training in bravery and self-possession.

253. Dreams. — When the brain is asleep, a few sets of cells may recall memories so vividly that they seem real. This is a *dream*. A dream is not an indication of what is to take place, but is only the shadow of what has already been done.

254. What the mind is. — No one has ever been able to find out what mind is. It is not the cells of the brain, for some of them have been destroyed in men, and yet the men have retained perfect minds. It seems to be the soul, or spirit of men, which lives in the cells and causes them to work for it. We believe that the mind, or soul of man, lives on after the cells in which it dwells are dead.

SUMMARY

1. The medulla oblongata acts for the head as the spinal cord does for the body. It also makes and sends out the orders for breathing.
2. The cerebellum gives us the power of balancing ourselves and of making exact movements.
3. The cerebrum is made of nerve cells covering a central mass of nerve threads.
4. The mind lives in the nerve cells of the cerebrum, and sends its orders out over its nerve threads.
5. The mind feels with the back and lower parts of the sides of the brain.
6. The mind sends orders for movements from the cells upon the top of the sides of the head.
7. The mind thinks with the cells behind the forehead.
8. By means of the nerve threads, the mind in the brain cells can talk with every cell of the body.
9. The mind is the spirit of man which, we think, lives on, even after its home, the body, dies.

CHAPTER XIV

NARCOTICS AND THE NERVOUS SYSTEM

255. How alcohol affects the mind. — Alcohol may weaken any part of the body, but this is of minor importance compared with its liability to ruin the mind and character of men. If alcohol is swallowed, but little can be found anywhere in the body at the end of an hour. But in its destruction it causes the albumin of the body to give rise to poisonous substances, which circulate everywhere among the cells. These poisons are probably what affect the nervous system of drinkers.

256. Alcohol and the spinal cord. — Because alcohol at first makes the heart beat stronger, it drives more blood through the spinal cord. This makes the nerve cells act more quickly, so that a person is bright and active, and feels as though he were stronger and more skillful than usual. He is ready to try foolish things and dangerous acts in order to show his skill. He notices every sound and movement and jumps at slight noises which do not usually annoy him. So he says he feels nervous and he takes more drink to quiet his nervousness. Finally he gets enough alcohol to weaken his cells so that they cannot notice anything, or send proper orders to feed the cells. Then he is dead drunk, and is in danger of his life.

257. Alcohol and thought. — Alcohol affects the brain in much the same way that it does the spinal cord. At first the blood flows more rapidly and makes the brain more active. A drinker is full of thoughts and is talkative, but

his words are mostly memories, and his thought cells in the forehead do very little new work. When alcohol begins to appropriate oxygen belonging to the body, the brain cells are the first to suffer. Those cells of the brain which do the highest kind of work suffer first. The thought cells in the forehead are the first to be weakened. The highest kind of work which they do is to make a person think of the feelings of others before his own. Drink makes a man selfish and he cares less for others' feelings and for what they think of him. He does not care if his clothes and face are dirty and if he is disagreeable to others. He is easily made angry and often wants to fight over small matters.

The next actions to be affected are thoughts of right and wrong. He steals without reason, and may commit murder. Many a criminal has made himself half drunk so that he could commit the crime from which he shrunk when sober.

Finally, all the cells under the forehead are weakened and the man cannot think at all. He does not think what might be the result of his acts, but is as likely to throw a lighted match into a pile of paper as into the stove. Many accidents and fires are due to the lack of thought of drinking men.

258. Alcohol and motion. — A person thus far under the influence of drink is often very amusing in his talk. He can still go about with a steady gait, but he cannot be trusted to do business. If he stops drinking, the effects will pass off in an hour or two. If he keeps on drinking, the cells which cause movements of the muscles are next affected. He cannot control his muscles, but walks with an unsteady gait. His hands tremble and he talks thick. He is now drunk.

259. Alcohol deadens feeling. — Next, the cells which

receive messages of feeling are weakened. Then the drunkard does not feel pain so keenly as he should. He gets injured without knowing it, and may fall and freeze to death without suffering. Before the days of chloroform surgeons used to make their patient drunk so that he should not feel the pain of the operation.

Because alcohol partly deadens feeling, it takes away the feeling of weariness, and the drunkard thinks that, because he does not feel tired, the whisky has made him strong. His mind is dulled; he has not the sense to see that he really has lost strength, and that his words and acts are foolish. He judges by the feeling alone and keeps on drinking, though each drink makes him still weaker and a still greater fool. But the next day the effects of the alcohol pass off and he feels a great weakness of his body and brain, and needs a day or two in which to recover. Yet in a little while there comes a desire to drink again. So once started, the habit grows, for a person's good sense is taken away, and he is too weak in mind to see the results.

260. Bad companions. — Another effect upon the mind of the drinker comes from his being with other men in the same state as himself. Their low stories and dirty language and quarrels make decent men ashamed. No person can hear them without being shocked. Yet men become like those with whom they live, and so drinkers learn to talk and think alike.

261. Light drinking. — A weakness of mind often comes on, even if a drinker never gets drunk, and it is often in a dangerous form. More insanity is caused by drinking than by anything else, and slow, steady drinking causes more of it than getting drunk and letting drink alone between times. Besides those who are made insane, many are so weakened

in mind as to be incapable of attending to business. Many a man has been compelled to give up his business because he has been a steady drinker in such small amounts that even his friends have not suspected him. His trouble is really a beginning insanity.

262. Delirium tremens. — There is a disease called *delirium tremens* which any drinker may get. Hard drinking alone may cause it, but an injury may bring it on in any drinker. Delirium tremens is a disease in which the victim imagines that he sees all manner of foul animals coming to torment him. The disease is one of the most terrible known, and is very dangerous to life.

263. Heredity. — Another evil, even greater than the others, is that the effects of drinking are handed down to one's children. Nervousness and weakness of mind and body often result. But worst of all, children often grow up with a *desire* for drinking. Yet no person has the right to drink because his father drank. It is within the power of any person to abstain from drink, if he will.

264. Drinking a disease. — The drinking habit is a disease of the mind. While a person should be punished for the crimes he commits while drunk, he should not be punished for drinking any more than an insane man should be punished for being insane. Neither should you laugh at the drinking habit any more than you should laugh at any other kind of sickness. The friends of a drinker must be the same comforters and helpers that they would be if he were sick in any other way. He must be led to use his will in putting away the habit. He should be made to know that he is sick and unfit for work. When people cease to be amused at drunkards and learn to treat them as sick in mind, drinking will become unpopular, for men do not like to be called sick. Fifty years ago men were

ashamed to say that they did not drink; now men are getting to be ashamed of drinking.

265. Waste from alcohol. — In the United States alone one and a half billions of dollars are paid for strong drink each year. The drink is made from good fruit and grain which can otherwise be used as food for man or animals. Bread costs the people less than half as much as strong drink. For every dollar spent for the support of churches fifteen are spent for strong drink. To pay the drink bill each year would take ten times more gold and silver than is mined. The price of two or three drinks, if it were put in a savings bank each day would amount to enough in ten years to pay for a comfortable home.

The loss to the drinker is only a small part of the whole loss. Because of sickness and loss of strength due to strong drink the men who hire drinkers do not get the full value for their money. In Great Britain it is calculated that the amount of labor lost by drink would amount to at least two hours every day for every workingman. The loss is made much greater if we count the accidents to property, health, and even to life caused by persons under the influence of strong drink.

We must add to this estimate the amount spent on jails and insane asylums, for over one half of all crime and insanity is directly produced by strong drink. We must also add the loss of great numbers of strong workers who once filled high positions but have lost them because of strong drink. We must also consider the loss of a far greater number of young men who would have risen to be respected citizens if it were not for strong drink.

To all this money waste we must add the amount of suffering and want which the drinkers' families at home must bear. We must also remember the number of chil-

dren who fall into bad habits from the lack of the good example and restraint of their intemperate parents. The money loss of strong drink can be restored, but the suffering can never be repaid. When all has been reckoned, it will be found that strong drink is the cause of more waste and evil than any other known thing. It affects every one in the land, therefore it is right to make laws which shall control the sale of liquor, or even stop its sale altogether.

266. Bitters. — There is a form of alcohol which many use and do not know it. Strengthening bitters, Jamaica ginger, and many tonics are simply strong alcohol with flavors added. They produce the same stimulating effects as whisky, and can easily make a person drunk. Their effects are due to their alcohol. Some persons even have a habit of their use just as men form a habit of using other kinds of alcoholic drinks.

267. Drug habits. — Opium and chloral are sometimes used to quiet the brain and to produce sleep. They are dangerous drugs, for after their effects have passed off, the brain feels worse than ever, and nothing but the same drug will make it feel well again. So persons form habits of their use. They quickly weaken the whole body, and affect the brain more than any other part. Those who use the drug seldom live more than a year or two. Many other drugs will also lead to slavish habits of taking them, but opium and chloral are the most common ones.

268. Headache powders. — There are a number of similar drugs made from coal tar which are used to relieve headaches. Phenacetine is the most common one. Under a doctor's direction they are valuable remedies; but many use them on their own responsibility, and finally find that they do not feel well without the drug. All these drugs weaken the heart and may produce violent poisoning.

269. Tea and coffee. — Many persons who use tea and coffee do not feel well without them. They stimulate the brain to greater exertion; but when their use is stopped the brain feels its weariness. Then another cup is needed, and so a habit of their use is formed. They often produce headaches and disordered stomachs, and so their habitual use weakens the whole body, including the brain. They often produce nervousness and sleeplessness. They should be regarded as drugs and not as food. Young people especially are easily harmed by their use.

270. Tobacco. — Men use tobacco to quiet their brains. When they are alone they use it for company, to keep from thinking, but when they are with others they use it because the rest do. On the other hand, some men use tobacco to make themselves think. Now, it cannot do both of these things. In reality, it does not increase the power of the brain, for it is a poison. Some men seem to stand tobacco with but little harm, but no one can use it and have the best brain.

271. Tobacco and drink. — Some people think that tobacco quiets a person's brain when he has been drinking. This is because tobacco lessens the overaction of the brain which alcohol at first produces. On the other hand, a little alcohol seems to make the tobacco user feel stronger, and to relieve his thirst caused by tobacco. So tobacco and alcohol naturally go together. A drinker almost always uses tobacco, for its poison seems to relieve the poison of alcohol; but it only seems to do so, for in reality it makes a person want more drink.

272. Waste from tobacco. — Like strong drink, the use of tobacco is extremely wasteful. In the United States half as much is spent for tobacco as for strong drink. The land upon which it is grown is not only prevented

from bearing useful crops, but is also soon worn out so that it will not produce any kind of a crop without large expenses for fertilizers. Many fires are caused by the careless use of matches in lighting pipes and cigars. While men often take strong drink because they may think it may do them good, they chew and smoke only for their pleasure. This tends to careless and wasteful habits of living. A man is seldom so poor but that he will have a smoke, even while his family may be compelled to live on charity.

273. Chewing gum. — Chewing gum is made from pitch, paraffin, and other thick and sticky substances which do not dissolve in water. The gum itself has no effect, for it is not dissolved and swallowed; but the act of chewing it causes a free flow of saliva when it is not needed, and so there will be less formed during meals when it is necessary for digestion. If gum from a dirty pocket is given to another person it may carry disease germs. Beyond this, chewing gum has little or no effect on the body. But its use is uncleanly and is unpleasant to others. It seems much like chewing tobacco, and refined persons avoid even the appearance of evil. Its use may encourage boys to chew tobacco later in life.

274. Alcohol in cooking. — In raising bread by means of yeast, alcohol is always formed, but the heat of the baking drives it off, so that all trace of it is lost. In preparing puddings, pies, and cakes, brandy or wine is often added to give them flavor. If they are cooked afterward, the heat will drive off the alcohol and so render the dessert harmless. If it is not cooked afterward the alcohol remains in the dessert and may do as much harm as if it were taken in the form of the original brandy.

Even when all the alcohol is driven off from a dessert,

the flavor of the brandy or wine remains behind and may teach persons to like the taste of the liquor itself. Children who eat the dessert may grow up to likè the taste of the liquor even though they never drank a drop of the liquor itself. In this way desserts flavored with liquor may do much harm.

In bread, the alcohol has no special flavor, and so we can eat bread without danger of learning to like the taste of liquors.

275. Alcohol in confectionery. — Candies sometimes contain brandy or whisky which is put in for their flavors. One form of candy has a hollow center filled with brandy. Children who buy the candy learn to like the taste of the liquor. The sale of brandy or of any other form of liquor in that way is a breaking of the law, for the candies contain more brandy than many strong drinks.

276. Homemade wines. — It must not be supposed that a wine is harmless because it has been made at home from good grapes or blackberries, without adding any alcohol at all. The alcohol in wine does not need to be put there, for the fruit juice ferments and forms it. If any liquor ferments at all it contains alcohol, and so is a strong drink. Homemade wines are often stronger in alcohol than many bought wines.

277. Strong drink as a medicine. — It is a custom to give some form of alcoholic stimulant whenever a person meets with an accident, or is seized with a sudden illness. It is doubtful whether it ever does much good at such a time. On the other hand, it may be the very thing which ought not to be given. For instance, if a person is bleeding, it may cause the blood vessels to become larger and so lead to a greater loss of blood.

Taking strong drink to break up a cold is liable to bring

on a greater cold by causing more blood to flow near the surface of the skin, where its heat will readily be lost.

The greatest danger of all in the household use of strong drink as a medicine is that children may grow up with the idea that it is a good thing to use under almost all circumstances. Thus it tends to encourage them in its use. No one can use an alcoholic drink with safety even as a medicine unless he is directed by a physician.

278. Treating. — A harmful practice connected with drinking is the custom of treating. Many a man would not drink if he were not invited by a friend. Then he does not dare to refuse either from fear of offending his friend or of being laughed at. He may be led to take several drinks against his will.

In Europe treating is seldom done. It would be much better if Americans would not induce their friends to drink. The custom and habit of treating is not confined to men and women, but children learn it in treating each other to candy. It is well to be generous, but it would be well to do a person good instead of harm by your generosity.

279. Ether and chloroform. — Alcohol is used in the manufacture of ether and chloroform. These two drugs are used to produce a deep sleep in which operations can be done on the body without giving pain. As soon as they are breathed into the lungs they begin to stupefy a person, but at first they also cause him to cry out and to toss himself about like a drunken man. In about five minutes he is in a deep sleep and can be kept so for an hour or two while the operation is being done.

When the ether or chloroform is stopped a person slowly awakens and talks in a wandering way for some time. In about half an hour he becomes wide awake again. The condition of a man who is deeply under the influence of

strong drink resembles the condition of one who has taken chloroform. But the effects of chloroform soon pass off, while alcohol acts slowly, so that a person may die before he can recover his senses.

SUMMARY

1. Alcohol interferes with the action of the nerves and spinal cord.
2. Alcohol overcomes the brain, first attacking its highest acts.
3. When a man is coming under the influence of alcohol, he first becomes selfish, and then careless. Then he cannot control his movements, and next he cannot feel. Finally he is dead drunk, and may die.
4. Continuous drinking, even if light, may overcome the mind so that it becomes insane.
5. In some cases alcohol causes horrible dreams called delirium tremens.
6. A drinker may transmit his mental weakness to his children.
7. Drinking is a disease of the mind.
8. Tobacco weakens the brain, as it does all other parts of the body.

CHAPTER XV

THE SENSES

A MAN knows what is going on around him in five ways. He can feel, see, hear, smell, and taste.

280. Feeling. — Nerves of feeling go to every part of the body. Most of them end in the skin. When anything touches them, they carry a message about it to the upper part of the brain. These messages are of three kinds: touch, pain, and temperature.

281. Touch. — When anything touches the body, but does not harm it, the nerves carry a message simply of touch. By means of this message the brain tells whether the substance touched is hard or smooth, or round or pointed, or has other qualities.

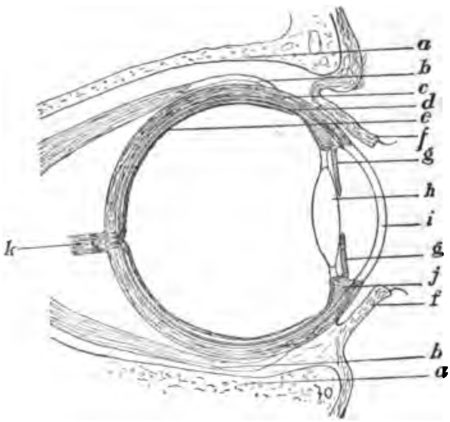
The tip of the tongue and the ends of the fingers are very sensitive. The fingers can feel two pins distinctly if they are only one twelfth of an inch apart, while the back feels them as one if they are two inches apart. We use the tips of the fingers if we wish to feel with accuracy.

By education, the sense of touch can be made very delicate. Blind persons learn to do things by touch almost as well as we do by sight.

282. Pain. — If anything touching the cells is harming them, we no longer feel a touch, but only a pain. Then we do not think whether the substance is hard, or smooth, but only that it is doing us harm. So pain tells us if anything is harming the body. A toothache shows that a

tooth is decaying and needs filling. If we could not feel pain, an arm or a leg might be burned or cut without our knowing it.

283. Temperature. — We feel heat or cold by special nerves in the skin. Draw a cold pencil point slowly over the face. You feel its touch as it moves over your face, but at a few points you feel only a coldness. These points are scattered over the skin so close together that the whole skin seems to feel the sensation. Whenever heat or cold is great enough to harm the body, we feel only a pain.



The human eye.

a bone of the orbit.
b muscle which moves the eyeball.
c sclerotic coat.
d choroid coat.
e retina.
f eyelid.
g iris.
h lens.
i cornea.
j muscle which changes the shape of the lens.
k optic nerve.

284. The eye. — The eye is a round white globe filled with a clear fluid. In its front is a clear round window, behind which is a muscular curtain called the *iris*. The iris is blue or brown, and gives the color to the eye. In its center is a round black hole called the *pupil*. The pupil

can become larger or smaller so as to regulate the amount of light which enters the eye. In a bright light it becomes small and shuts out some of the rays. In a dim light it becomes large, and admits all the light it can. Notice the pupil of a cat's eye. In the middle of the day it is a narrow slit, but in the evening it is almost round, and admits more light than the pupil of a man's eye. A cat can see well when it is so dark that we cannot see at all.

Behind the pupil is a clear body, shaped like two saucers put together by their edges, or like a magnifying glass. It is called a *lens*. A magnifying glass brings rays of light together into one bright spot. The lens of the eye brings together the rays from an object, and they form a picture upon the nerves in the back part of the eyeball, like a picture in a photographer's camera. The nerves carry the impression of the picture to the back part of the brain and so produce sight.

285. Movements of the eyes. — The eyes can be turned in any direction we wish by means of muscles. Sometimes the eyes will not turn together, but while one looks at one object, the other looks somewhere else, making the person *cross-eyed*. A cross-eyed person usually sees with only one eye. If the eye is treated before a child has grown, it can be cured.

286. Coverings of the eyes. — The eyeball lies upon a bed of fat in a bony case. It is covered in front by two lids of flesh. These can be shut so as to protect the eye from dust or injuries. Whenever anything is about to enter the eye, it causes the lids to close so as to shut it out. We cannot help winking when something is about to strike the eye. When we are sleepy, we cannot keep the lids from falling together.

Hairs grow from the edges of the lids. They curl

away from the eyeball so as to catch whatever might fall against the eye.

287. Dirt under the lids. — The front side of the eyeball and the lining of the lids are very tender. If only a little dirt gets under the eyelid, it gives great pain. Then the eye should be kept still until the dirt can be taken out. Rubbing grinds the dirt into the eye and makes it sore. Never rub the eye when you think it has something in it. Lift the lid by the eyelashes and the tears will usually wash the dirt away. If they do not, let some one raise the lid and pick out the dirt with a soft handkerchief.

288. Tears. — The eyeball is moistened with a saltish liquid called *tears*. They are produced by a gland situated just above and to the outside of the eye. They run over the surface and down a small tube, and into the nose. Winking rubs the liquid over the whole surface of the eye so as to wash away dust. When you cry, the tears flow faster than the tube can carry them into the nose. Then some overflow upon the cheeks.

289. Care of the eyes. — Your eyes ought never to ache from use. If they do ache, you are straining them and may do them great harm. You can use your eyes safely until they begin to ache. At the first signs of discomfort, you should stop work and give them a rest.

A bright light in front of the eyes is the most common cause of eye strain. At night there should always be a shade over the lamp, or else you should wear a shade over your eyes. A cap will do for a shade if you cannot get anything else.

The light should come from one side or over your shoulder. Then it will not shine into your eyes. You should never try to look at the sun. You should never try to read by a dim or unsteady light.

In a carriage or a railway car, your paper will shake, and you must be continually moving your eyes to see. This makes the eyes ache. You ought not to try to read under these conditions.

When you read while lying down, you turn your eyes in the direction of your feet, which is very tiresome.

290. Nearsightedness. — In order to see objects clearly, some persons must hold them close to their eyes. This is called *nearsightedness*. Nearsighted persons should always wear spectacles. This will enable them to see as well as any one.

291. Farsightedness. — As persons grow old, they cannot see near by so well as afar off. This is called *farsightedness*. By wearing spectacles, they can see as well as ever.

292. Alcohol and the eyes. — Alcohol causes the eyes to look red, and may make them sore. In some cases it causes the nerves of the eye to waste away. Then the eye will be blind, although it will appear well.

In drunken persons the muscles of the eyes, like the muscles of the legs, do not act rightly. They often turn the eyes in different directions. Then the person will be cross-eyed, and every object will seem double.

Tobacco, in some cases, causes the nerve of sight to waste away. Tobacco smoke makes the eyes smart so that the tears flow.

293. The ears. — We hear with our ears. Sound is made by waves of air which beat upon special nerves. The ear is a cavity, hollowed out of a very hard bone, and is divided into three parts.

294. The outer ear. — The outer ear, which we see, is not needed, but it does some good in catching the waves of sound and throwing them into the tube in its center.

This tube enters the skull. The tube and the ear which we see are called the *outer* ear.

295. The middle ear. — At the end of the tube of the outer ear a thin membrane is stretched like the head of a drum. Beyond it is a hollow cavity which is like a drum, and is called the *middle* ear. Air waves strike

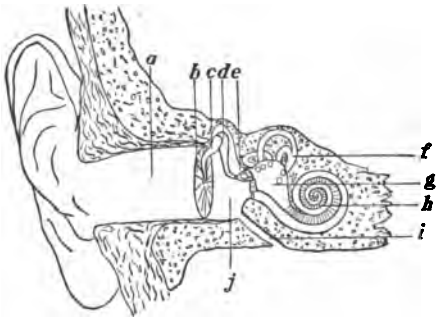


Diagram of the ear.

a outer air passage.
b membrana tympani.
c malleus, or hammer bone.
d incus, or anvil bone.
e stapes, or stirrup bone.
f semicircular canals.
g vestibule of inner ear.
h cochlea.
i Eustachian tube.
j tympanum, or middle ear.

the drumhead and cause it to move rapidly back and forth, just as a drumhead moves when it is struck. A chain of three little bones stretches across the drum and carries the movements of the drumhead to a third cavity called the *inner* ear.

296. The inner ear. — The inner ear is made up of coiled tubes. It is filled with a clear liquid into which the nerves of hearing project. The movements of the little bones produce waves in the liquid, which beat against the nerves. Our brains feel the waves as a *sound*. The outer ear conducts the sound to the middle ear. The middle ear acts

like a sounding box to make it plainer and more distinct. The inner ear is the real ear. Some animals, like fish, have only an inner ear.

297. The Eustachian tube. — The middle ear is filled with air. From it a tube, called the *Eustachian* tube, extends to the back part of the nose. When you blow your nose hard, you can force air up the tube. This makes your ears feel full, and you become partly deaf. When you have a cold, the tube may become stopped, and then your ear rings and feels as if you had blown air up the tube. If it stays stopped, you may become deaf.

Sometimes a cold in the throat extends up the tube and into the middle ear. Then you have an earache, and perhaps your ear may discharge matter like that from your throat. Throat trouble is the most common cause of earache and deafness in children. If a child breathes through his mouth or has too large tonsils or anything growing in the back part of his nose, he is very liable to have earache or deafness. So it is very important for you to have your nose and throat in good order if you would have good hearing. Scarlet fever often causes deafness, because the inflammation of the throat extends up the tube to the ears.

298. Dull children. — Sometimes children get throat trouble and earache before they can talk. Then they grow up slightly deaf, but neither they, nor their parents, nor their teachers know it. Such children cannot hear well when spoken to, and so seem to be dull and careless. Often they are punished for not attending to their work. This is very unjust to the child. Every child that seems inattentive or slow in obeying should have his hearing tested. Hold a watch to his ear and see if he can hear it as far away as you can.

299. Care of the ears. — Boxing the ears may burst the

drumhead, just as hitting a drum too hard may spoil it. This may cause deafness. You should never strike a person upon the ears in play. A very loud noise may also burst the ear drum, or at least cause pain and deafness. You should stop your ears when you expect a loud noise. Men who shoot cannon often have to put cotton into their ears before they fire.

Cold water in the ear may cause an earache. When you get water in your ear while you are in swimming, turn your head to one side and shake it so that the water will run out.

Do not put anything into your ear. It is very hard to get a bean or a stone out again. Cotton in the ear makes the ear tender and causes more colds than it prevents.

If the ears run with matter, wash them out with clean water and borax. Do not plug them up with cotton or anything else, for that will keep the matter in.

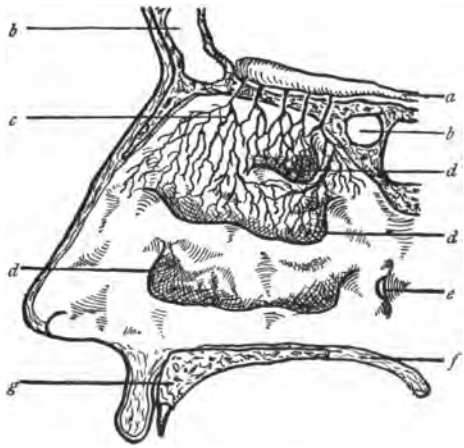
300. Ear wax. — The outer tube of the ear produces a kind of bitter wax. This keeps insects from crawling into the ear. Sometimes it collects into a mass. By trying to get it out you may force it farther into the ear and against the drumhead. Then you will become partly deaf.

You should not pick your ears, for you may hurt the drumhead. The wax naturally grows outward, and so does not collect in the ear if it is left alone.

301. The nose. — We smell with the nose. In the upper part of the nose fine nerves are spread out beneath the epithelium. When a vapor in the air soaks through the wet sides of the nose, it touches the nerves and produces the sense of smell.

In order to have a smell, a substance must become a vapor. So those substances which cannot become a vapor have no smell. A very small amount of a substance in the

air will excite the sense of smell. A tiny grain of musk will continue to give out vapor and produce a smell for years, and yet will not seem to diminish at all in size.



The outer wall of the nose.

a the nerve of smell at the base of the brain.
b air spaces in the skull bones.
c branches of the nerve of smell.
d curved curtains of bone.
e opening of the Eustachian tube.
f soft palate.
g upper jawbone.

302. Use of smell. — Spoiled food and bad air each give off a bad smell, while good food and good air always smell good. The sense of smell guards us against bad air and bad food.

When we have a cold in the nose we cannot smell. We must keep from taking cold if we would have a good sense of smell.

Alcohol and *tobacco* are irritating to the nose, and spoil the sense of smell. Then the great safeguard against bad air and bad food is taken away.

303. Taste. — The nerves of taste are situated mostly

upon the tongue. A substance dissolves in the saliva and soaks through the epithelium of the tongue, and touching the nerves produces the sense of taste. A substance that will not dissolve in water has no taste.

The sense of taste tells us what food is good for us. Unwholesome or spoiled food generally has a bad taste. We can learn to like some things that are not good for us. Tobacco does not taste good at first, but men learn to like it. We never tire of the taste of wholesome food, but when we get too much sweets or candy, their taste makes us sick. Even if a thing tastes good at first, its taste may afterward show it to be unwholesome.

We should not injure the nerves of taste by using tobacco or alcohol. Even pepper and spices may injure the taste so that we cannot tell when food is bad.

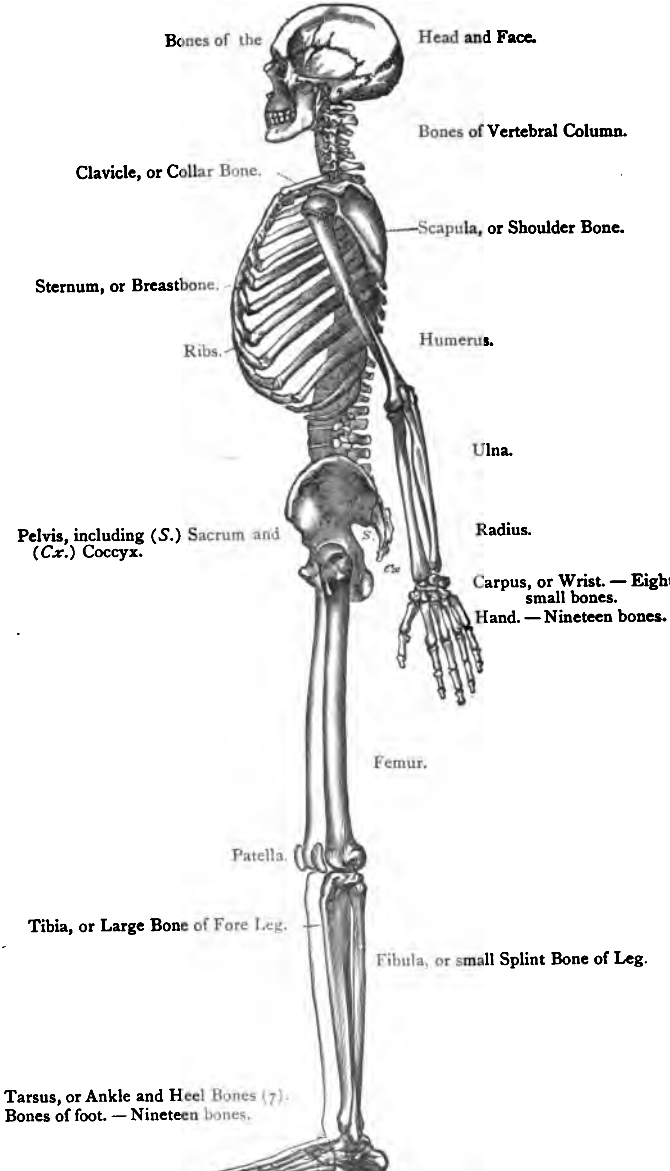
Sometimes the senses of smell and taste blend together. If the sense of smell is lessened, as by a cold in the head, coffee does not taste so good as it should. If the nose is stopped, persons can scarcely recognize the taste of onions.

SUMMARY

1. Anything touching the nerves produces a feeling of touch, or of pain or of temperature.
2. Touch tells us about the shape, hardness, smoothness, and similar qualities of objects.
3. Pain tells us that something is harming the body.
4. Light passes into the eyeball and forms a picture upon nerves, and thus produces the sense of sight.
5. Muscles turn the eye about, lids protect it, and tears wash away dust from it.
6. Too bright a light harms the eyes.
7. Air waves pass into the tube of the outer ear, and are carried across the middle ear by a chain of bones to

nerves in the inner ear, where they produce the sense of sound.

8. The Eustachian tube leads from the middle ear to the back part of the nose. A cold in the head stops the tube and causes earache and deafness. Most earaches are caused by a cold in the throat.
9. Little particles in the air soak through the wet sides of the nose and, touching the nerves beneath, produce the sense of smell.
10. A substance soaking into the surface of the tongue and touching its nerves excites the sense of taste.
11. Smell and taste guard us against bad air and bad food.



The Human Skeleton, showing position of bones.

CHAPTER XVI

BONES

304. Need of bones. — Besides eating, breathing, and sleeping, man's body does a great deal of heavy work that would crush a soft body. Man also goes from place to place and carries heavy weights that he could not carry if he did not possess something on purpose to move his body. Inside the body is a stiff and strong frame of bone, which is moved by muscles. Bones form the frame of nearly every part of the body, while the muscles which cover them make the body plump and round. About one seventh of the body is bone, while over one half is muscle. In all there are over two hundred bones in the body.

305. Shape of bones. — Long bones extend down the arms and legs, and slender bones form the fingers and toes. Flat, curved plates of bone form the skull. Rounded bones form the wrists and ankles, and rings of bone form the backbone. Bones are of different shapes in order to fit into the different parts of the body.

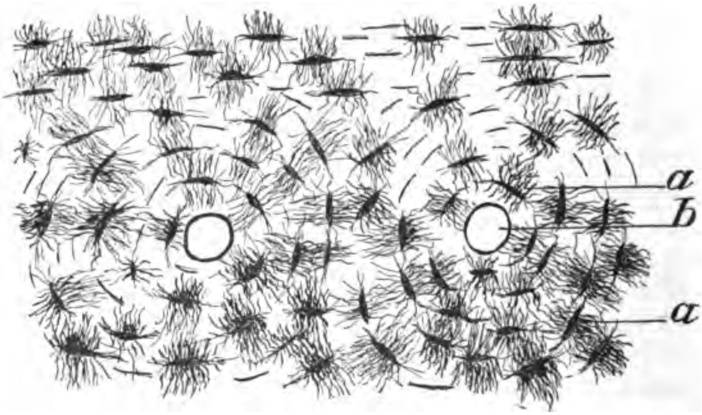
Each long bone is a hollow shell like the frame of a bicycle. This makes it strong and yet light. Its hollow inside is filled with a soft fat called *marrow.*

The ends of long bones are like a fine honeycomb covered with a hard shell of firm bone. This makes them light and yet able to resist the pressure of the body above.

306. Strength of bone. — Each bone is very hard, and

yet it can be bent somewhat without breaking. It is twice as strong as an oak stick of the same size.

307. Structure of bone. — A bone is made of living cells fed by the blood. From the cells there go out fine strings of connective tissue. Lime is mixed among the strings like starch among the fibers of a linen collar. This makes



Thin slice of bone (× 200).

a bone cells. *b* Haversian canal, containing blood vessels and nerves.

the bones hard. About one third of a bone is made of the living cells and two thirds is lime. Under a microscope we can see that the cells form circles around small blood tubes.

A bone is covered with a tough membrane called the *periosteum*. The periosteum forms new cells and makes the bone grow. If the bone is removed and its periosteum left, this will form a new bone in a few weeks. Bone grows and wastes away, but it changes much slower than any other part of the body.

The place where bones join together is a *joint*. Some joints can bend and others cannot.

308. The skull. — The frame of the head is called the *skull.* It is made of twenty-two flat plates of bone. Those that cover the brain and the other parts of the head are thick and strong, for they are likely to be hurt by blows. The bones which make the nose and the inside of the skull are thin, for they have little work to do, and blows cannot reach them.

The bones of the skull are joined together by rough edges, which fit exactly into each other. In a man some of these bones grow together into a single bone. These joints can move only enough to prevent a little of the jarring when we jump or strike the head against something hard, but in a young baby the bones can be moved and the head can be pressed into any shape.

309. The spine. — The skull is balanced upon a stiff string of bones called the *spine* or *backbone.* The spine runs the whole length of the back, and is made up of thirty-three rings of bone; but in a man the lower ones grow together so that there are only twenty-six separate rings. The spinal cord is hung in the middle of these rings. Between the rings are thick, strong pads of tough flesh or gristle which make strong, close joints, and also act as springs to keep the body from being jarred when we run or jump. By means of these joints the backbone can be bent and twisted, but the motion is small. In the circus are men whose backbones are so loose jointed that they can twist themselves into a knot.

310. Ribs. — From the sides of the backbone slender bones, called *ribs,* extend around the sides of the body, and are joined in front to the sides of a flat bone called the *breast bone.* There are twelve ribs on each side. They have a little motion up and down, and out and in, as in breathing. They form a box called the *chest.*

311. The pelvis. — The backbone rests upon a large and strong ring of bone formed by the *hip bones*. The hip bones form a round bottomless basin called the *pelvis*. There are three bones in the pelvis, and the joints between them are close fitting and strong. We sit upon the bottoms of the two hip bones.

312. The legs. — From each side of the pelvis a long bone reaches downward to form the framework of the leg above the knee. This bone is called the *femur*, and is the largest, longest, and strongest bone in the body.

Reaching from the knee to the ankle is a long and strong bone called the *shin bone* or *tibia*. Upon its outside is a long slender bone called the *fibula*. The lower end of the fibula forms the lump of bone which is called the outer ankle bone. The inner ankle bone is formed by a small tongue of bone from the tibia.

313. The instep. — Below the shin bone are seven small rounded bones which are very tightly bound together by strong bands of connective tissue. They form the *instep*, or arch of the foot. This arch supports the weight of the body while we stand. So it is made very strong. A single bone would not spring, but the whole body would be jarred at every step. The arch is made of several bones each of which will spring a little. So when we jump or run, our bodies are but little jarred. The pads between the rings of the spine also keep the body from being jarred.

At the end of the instep are nineteen slender bones joined end to end in five strings. The first bone of each string is buried in the flesh, and together they form the sole of the foot. They are called *tarsal* bones. The remaining bones of each string form the toes.

314. The shoulder. — Two bones at the lower part of the neck upon each side form a frame upon which the arm is

hung. The bone in front is slender and long and is called the *collar bone*, or *clavicle*. Its inner end rests against the breast bone. The bone behind is flat and forms the *shoulder blade*, or *scapula*. It is not joined to any bone, but is hung only by muscles. These two bones form the shoulder.

315. The arm. — From the side of the shoulder a long, strong bone hangs down to form the frame of the arm above the elbow. It is called the *humerus*. At the elbow it joins two other bones which form the frame of the arm below the elbow. The bone upon the thumb side of the arm is called the *radius*, and upon the little finger side, the *ulna*.

316. The wrist and hand. — At the ends of the radius and ulna are eight small, rounded bones which form the wrist. These bones are firmly joined together by connective tissue like the tarsal bones of the foot. They make the wrist more springy than it would be if it were a single bone.

At the lower end of the wrist are nineteen slender bones, joined end to end so as to form five strings of bone as in the foot. The first bones of each string are buried in the flesh and make the frame work of the palm of the hand. The outer bones of each string form the fingers.

317. Hand and foot compared. — The hand and foot are each made of the same number of bones and upon the same plan. The instep is much larger and stronger than the wrist, for it must bear great weights. The toes are much shorter than the fingers, but they have the same muscles and can be moved in the same ways. The great toe cannot be turned in so as to be brought against the other toes as the thumb can against the fingers. The foot would be a very clumsy hand, yet some persons who

have been born without hands have learned to use their feet instead.

318. Joints. — The bones of the skull and pelvis can be moved but little. Their joints permit these bones to grow and also make them slightly springy.

The bones of the spine, instep, ribs, and wrist can move a little. Each bone moves scarcely enough to be noticeable, but altogether they have a considerable range of motion.

The bones of the arms, fingers, legs, and toes and the lower jaw can be moved freely. In them the end of one bone is rounded and fits snugly into a hollow in the other bone. The two bones are bound together by tough bands called *ligaments*, which encircle the joint like a loose collar. Thus the bones are free to move like a door upon its hinges.

319. Cartilage. — The ends of bones in the joints are covered with a thin layer of a very tough and firm substance called *cartilage*. Cartilage is like bone without lime. The bone of young animals is cartilage at first, but as it grows it takes up lime, except at the ends, which remain cartilage.

Hinge joint of the elbow.
1 humerus 2 ulna

320. Synovial membrane. — The inside of a movable joint is lined with a bag called the *synovial membrane*. The synovial membrane is very smooth and is filled with a liquid like the white of an egg. This oils the joint and makes it work smoothly. Sometimes in old people the synovial fluid dries up. Then the joint is stiff and creaks when it is bent.

321. Hinge joints. — In the fingers, toes, wrists, ankles, elbows, and knees the surfaces of the joints are long and round like a hinge. So they can open and shut in one direction only like a penknife. In the other direction they can only straighten the limb. If you bend the limb in the wrong direction, you will break the bones or else put them out of joint.

322. Ball and socket joints. — The shoulders and hip joints can be moved in any direction. In each the upper end of the bone of the limb is round like half of a ball. This fits into a cup in the other bone. Thus the limb can be turned in any direction. In fourfooted animals the fore and hind legs cannot be moved nearly so freely as a man's arms and legs. So these animals could not do a man's work even if they had hands.

323. Broken bones. — The bones of children are more springy and are softer than those of old people. A child may fall very hard without danger, while an old person's bones will break from a slight fall. But a grown person weighs many times as much as a child, and so, when he falls, there is more strain on the bones.

When a bone is broken, its ends must be put in place, or "set," and kept there by splints and bandages. Then new cells grow in place of the injured ones. Lime is mixed with the new cells, and the bone repairs itself in about a month. It will then be as strong as it was before it was broken, or even stronger. If the ends of the bones are not put in their proper place and kept there until healing begins, the bone will grow crooked.

324. Sprains. — When a joint is bent too far, or in the wrong direction, its ligaments are stretched and partly torn. This makes a *sprain*. A sprained joint is very tender and painful, and gets well slowly.

When you sprain a joint, you should put it at once in hot water for an hour or two. This will relieve the pain and swelling. Then you should keep the joint at rest for a few days.

325. Bones out of joint. — When the end of a bone is out of its socket, the bone is out of joint. Then movements of the limb will be painful or impossible. If a bone gets out of joint, the ligaments become badly torn and will heal slowly. A bone out of joint is as bad an injury as a broken bone. It will be necessary to put the bone in place and keep it there by splints and bandages. It is treated like a broken bone.

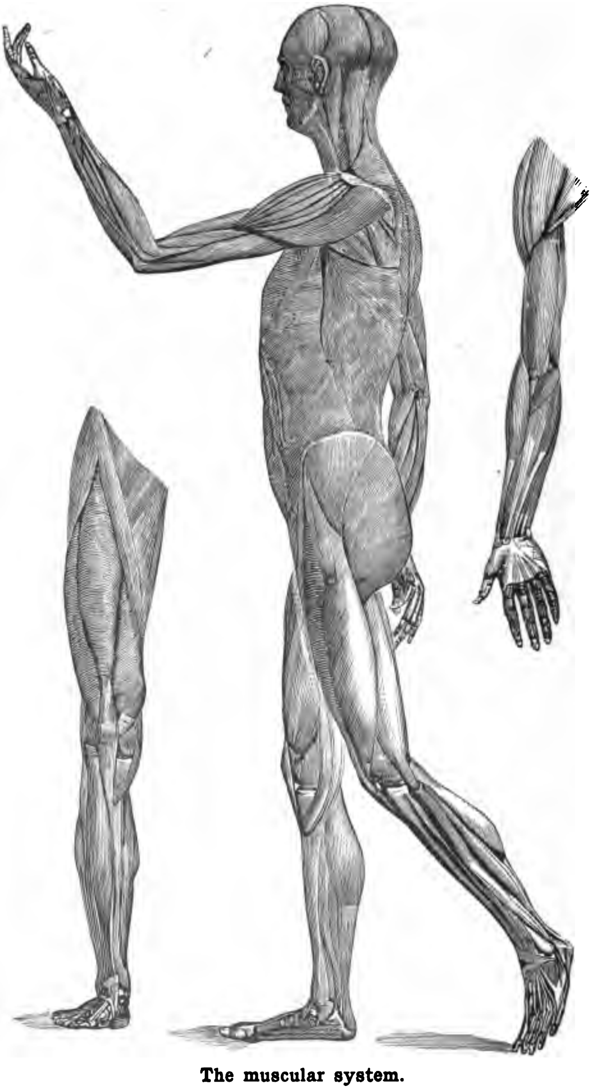
326. Effects of improper positions. — When a bone or joint is bent, it will return to its former shape. If it is kept bent in one direction a large part of the time, it slowly grows into that shape. If you always lean to one side while sitting at the desk, the backbone will finally become curved in that direction. If you sit round-shouldered, after a while your bones and joints will make you keep that shape. A round-shouldered person has small lungs. He is apt to be short-winded.

327. Tight shoes. — If your shoes are tight, they will cramp your toes and make them grow out of shape. The big toe of a baby points forward in a line with the inside of the foot. It points forward in very few men or women, for their tight shoes force it inward until it stays in that position. The ends of the toes should be square with the sides of the feet. Tight shoes cramp the toes and make them pointed. When the tight shoe rubs the skin, it causes the epithelium to thicken and form a *corn.* If it forces the big toe inward, it harms its joint, making it swell and become painful. This forms a *bunion.* The cure for corns and bunions is to wear loose shoes of the shape of the foot.

By sitting, standing, and walking erect, we can make our backbones straight and our chests full. A soldier is straight because he has had to keep his back straight until it grew so.

SUMMARY

1. Two hundred bones form a strong frame for the body. Some are long and some are flat.
2. Bones are made of living cells, in which lime is mixed to give them stiffness.
3. The union of two bones is a *joint*. Some, as those of the head, cannot be moved. They allow the bones to spring a little instead of breaking, when they are hit or pressed.
4. The bones of the spine can move a little, for they are joined together by pads like rubber cushions.
5. In the arms and legs the bones fit together by means of rounded surfaces. They are covered with *cartilage* and are held in place by loose ligaments.
6. Joints are oiled by a fluid like the white of an egg, called the *synovial* fluid.
7. Most joints move back and forth like a hinge. The shoulder and hip can be moved in any direction.
8. The cells of a broken bone soon fill in the gap with the new cells, and then deposit lime in the new part. This heals the bone.
9. In sprains, and when bones are out of joint, the ligaments are torn and require a long time to heal.
10. When the body keeps an improper position for days at a time, it will grow into that position.

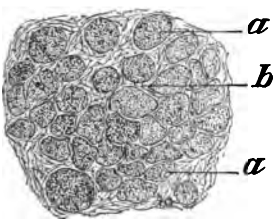


The muscular system.

CHAPTER XVII

MUSCLES

328. Use of muscles. — The bony framework of the body is covered and rounded out by muscles. Muscles form one half of our weight. They are the servants of the mind, and do its physical work, while the brain does its mental work. If the brain and muscles did not wear out, there would be no need of a stomach.



Muscle cells, cut across (× 200).

a muscle cell.
b connective tissue binding the cells together.

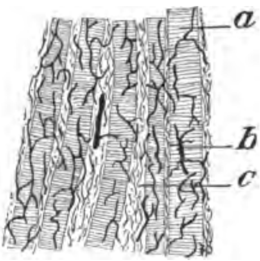
As it is, the stomach, heart, lungs, and other parts are needed to feed and to keep the muscles and brain alive and well.

329. Structure of muscles. — Lean meat is mostly muscle. A muscle is large at one end or in the middle, and is fast to a bone. Its other end generally grows smaller and is prolonged in a strong cord called a *tendon.* The tendon crosses a joint and is fast to another bone.

Each muscular bundle is made of cells like strings. These are the largest cells in the body, but they cannot be seen without a microscope. They are bound in small bundles by delicate strings of connective tissue. These bundles are bound into a large bundle which we call a muscle. Each large bundle of muscle is covered with a thick woven skin of connective tissue. Finally, all the

bundles of a limb are bound together by a very thick sheet of the same tissue. You can see these bundles and their tough coverings in any meat.

330. Action of muscles. — A nerve thread touches every muscle cell. When it brings an order to act, each muscle cell makes itself thicker and shorter. Thus the whole muscle becomes shorter and pulls upon whatever is fast to its ends. The usual action of a muscle is to bend a joint.



A thin slice of a voluntary muscle, cut lengthwise (× 100).

a muscle cell.
b capillaries surrounding the cells.
c connective tissue binding the cells together.

The messages sent to the muscles come from the cells of the spinal cord. They send messages to the muscles either in a reflex way or when told to do so by the cells of the brain. Muscle and brain cells are the only cells of the body which can be made to act whenever we wish them to.

331. Involuntary muscles. — There is a kind of muscle which we cannot make act by an effort of the will, but which the spinal cord keeps in action in a reflex way without our knowledge. Such muscles are found in the stomach, intestine, arteries, and skin. They are the muscles which aid the digestion of food and the flow of blood. The spinal cord and sympathetic system send them orders without our knowledge. It is well that nature has put these muscles beyond our control, for we might forget to attend to them. They are called *involuntary* muscles, because we cannot make them act. These muscles are made of cells with long pointed ends. Instead of being solid masses, they form thin leaves around tubes.

332. How to see muscles. — Shut the hand tightly, and notice that the arm just below the elbow becomes harder and larger. This is because the muscles which shut the hand are situated upon the arm. You can feel and see the ridges formed by each bundle of muscle while it is acting. You can feel their tendons as they cross the wrist. Some end in the palm of the hand, and some go on to the fingers. There are a few small muscles in the palm of the hand, but most of the finger muscles are in the arm. There are no muscles at all in the fingers.

The muscles of the foot are upon the leg below the knee. They end in tendons which go to the toes like the tendons to the fingers. The tendon above the heel supports the weight of the body when we stand on tiptoe. It is the largest in the body, and is called the *tendon of Achilles.*

Muscles which bend a joint are usually much stronger than those which straighten it, for most of our work is done by bending the joints.

333. Strength of muscle. — Lean meat seems soft and almost like jelly, yet it can contract with great force. The muscle upon the front of a man's arm can put forth a force of nearly a thousand pounds, but its tendon is attached so near the elbow that we can really lift about a hundred pounds with the hand. Most muscles have to put forth a strength more than equal to the weight which they move.

A grasshopper seems to be very strong, for it can jump a hundred times its own length. But a grasshopper is very light, and has but little weight to carry. A piece of man's muscle of the size of a grasshopper's is really far the stronger.

334. How to increase the strength. — By use, a muscle becomes larger and stronger. When a boy wishes to go into a race, he uses the muscles of his legs every day until

they are large and hard, and he can run very fast and long without getting tired. But using the muscles of the leg does not make the arm stronger. We must use every muscle if we would get strong all over.

If we stop using our muscles, they soon become weak again. If you break your leg and have to keep it still, it will soon become small and weak. Then the other one will grow larger, for it has to work harder to carry you around.

If you use your muscles until you strain them, they will grow weaker instead of stronger, for you will wear them out faster than the blood can feed them. You ought not to strain yourself trying to lift as much as a grown man lifts, or to run as far as a large boy runs.

335. Round shoulders. — The muscles of our backs hold us erect and keep our shoulders thrown back. A lazy boy lets his shoulders fall, and supports himself by leaning against the wall. Sometimes braces are used to keep the shoulders back. This rests the muscles, and lets them grow still weaker. The best way to make the body straight is to make the muscles hold the shoulders back. This is what soldiers do. Military drill tends to make boys straight. Working women of Europe often carry heavy burdens upon their heads. In order to do this, they must walk erect and steady. These women are noted for their straight backs and graceful walk. A drill in carrying loads upon the head would be of great value in making young girls walk gracefully.

336. How exercise makes the body healthy. — The muscles are the engine of the body. The food is the fuel. Oxygen burns the food and makes heat, which the muscles turn to power. When a muscle acts, it needs a great deal of heat. So it must have more food and air, which is brought by the blood. In order to support it, the heart

beats faster and stronger and the stomach acts better. The whole body does better work so as to supply the muscles with power. The brain also feels the effects of the increased action of the body. Use of the muscles makes us feel better in every way. When we have studied or written all day, we have taken only a few deep breaths. Our fires burn low and become clogged with waste matter. If we now exercise for a few minutes, we shall start up all the actions of the body and shall feel fresh again.

Some men work hard and are healthy until they get rich. Then they stop work at once and try to enjoy their rest. But they find that their food does not digest, and that they cannot breathe well. Their brains are clouded and their heads ache. The trouble is that their muscles do not need food, and so the body does not prepare it for them. If they should do light work, they would feel all right.

We can use our muscles in order to grow strong. This alone will not do us much good, for men can use machines to do far more hard work than a large number of men can do. We also use our muscles so as to grow healthy. This should be the object of exercise. Every one should do some work with his muscles every day. Girls and women need exercise as well as boys and men.

337. How to exercise. — The best exercise is that in which some useful work is done. A farmer's boy grows strong and does not think of his exercise. Work about the house or barn is the best kind of exercise. Every child should have some regular work to do night and morning. It will make him stronger and will also teach him how to work.

It is well to teach boys and girls some trade. Carpentering is exercise, and also gives them useful knowledge.

Gardening and housework are also exercise, and should be taught to every child.

A bicycle affords good exercise. If a person does not race or go on long rides, it will do him no harm. Even old men and very small children can ride it safely.

Gymnasiums are of great value in taking exercise. By the use of dumb-bells and Indian clubs, and by lifting light chest weights, any weak part of the body can be made strong. The only trouble in the use of these is that we soon get tired of one thing. In classes and under a teacher they afford interesting and profitable exercise.

338. The face muscles.—The muscles of the face are flat and fastened to the skin. When they act, they draw

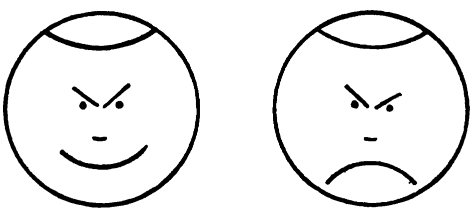


Illustration of the change of expression produced by the muscles of the mouth.

and pucker the skin in different directions. Each kind of feeling in the mind causes the muscles to act in a certain way. If we feel happy, the muscles draw the ends of the mouth upward and backward. This makes a smile. If we feel sad, the muscles draw the ends of the mouth down. By looking at a person's face we can often tell how he is feeling.

339. Effects of alcohol and tobacco.—Alcohol appropriates oxygen belonging to the muscle cells and prevents the stomach and liver from preparing food for their use.

Consequently, it weakens the muscles. It may seem to make a person stronger, for it deadens his tired feelings. But in reality he has less strength than if he had let drink alone. A single drink begins to weaken him. Alcohol cannot take the place of food, for food is the only thing to give strength to the body. Drugs may deaden tired feelings, but they cannot add to one's strength.

Alcohol sometimes causes little drops of the muscle cells to change to fat. This greatly weakens the cells. Beer often does this. A man may seem to be very fat and strong from its use, but fat does not give strength.

Tobacco is a poison to all the cells of the body, and it never becomes anything else. No man who is training for a race dares to use tobacco.

340. Alcohol and endurance. — Men sometimes have to make long journeys across hot deserts or in cold Arctic regions, or have to endure great fatigue and suffering in war. It used to be thought that strong drink gave men greater power for undergoing these heavy labors, and so men in armies and exploring expeditions always carried regular supplies of rum, which was doubled just before a battle or an extra strain. Men who refused to drink were laughed at; but it was noticed that they did more work and enjoyed better health than the drinkers. Then careful experiments were made to determine whether men could do without liquor. In every case men in hot climates felt better, while those in polar regions endured the cold better than those who used it. The government of the United States long since stopped giving liquor to the soldiers and sailors. Arctic explorers do not carry it except for scientific purposes. Even hard drinkers carefully avoid liquor while they are training.

A few years ago a man would have been called foolish

if he did not drink while doing hard work. Mowers each took a drink from a common jug at each round of the field. One man remarked, "I could mow without rum as well as any one if it were not for the looks of the thing." Rum was used freely at every church raising. Now all this has changed. Fashion no longer requires men to drink. On the other hand there is a growing knowledge of its harm, and an increasing custom of letting drink alone.

341. Tobacco and strength. — Formerly men thought that tobacco helped men to work hard and to endure fatigue. Now men know better, but because its effects are not so great as those of alcohol, men are slower in giving up its use. Still its effects are so great that men who train for races will not use it any more than they would strong drink.

It is everywhere admitted that the use of tobacco by the young hinders the growth of the body. Careful measurements of young men in schools and colleges show that smokers do not grow so fast nor so large as those who do not smoke. Cigarettes are especially harmful to the young, and yet boys and young men are almost the only persons who buy them.

342. Life insurance and drinking. — The most convincing proof of the evil effects of strong drink is the records of life insurance companies. When a person asks to be insured the company makes a careful inquiry and an examination to find out the state of the candidate's health and his habits in regard to drinking. If he is accepted he pays a certain sum each year. Then, after a certain number of years, or at his death, a sum of money is paid to him or to his family. A person at any given age may be expected to live and to pay premiums for a certain number of years. Some die sooner and some live longer; but the amount

which they all pay nearly equals the amount which the company had calculated they would have paid if all had lived a given number of years. According to life insurance tables a healthy man, at 20 years of age may expect to live 44 years more; at 30 years of age, 36 years more; and at 40 years of age, 28 years more. If a man is a moderate drinker, at 20 years of age, he may expect to live 15 years more; at 30 years of age, 14 years more; and at 40 years of age, 11 years more. As a mere matter of business a company will not insure a drinker, for they cannot afford to pay a large sum of money if the person is not likely to live long to make them yearly payments. Thus, a healthy man insured at 20 years of age, will make yearly payments for 20 years longer than a drinker.

343. Why strong drink shortens life. — Strong drink is a poison which is strong enough to produce death in itself. A great many drinkers die from the effects of strong drink alone.

Strong drink also weakens the body so that it cannot resist diseases which it otherwise could endure. In epidemics of small pox, cholera, yellow fever, and such deadly diseases, drinkers are more apt to take the disease than those who do not. Of the sick, drinkers are the first and often the only ones to die. Surgeons hesitate to operate upon drinkers, for their wounds heal slowly, and they take chloroform poorly. It is true that some drinkers escape the greater dangers of alcohol, but the risk that a drinker runs of being seriously harmed or killed, is far greater than the risk that a soldier runs of being hurt in a battle.

344. A long life. — A healthy body is the noblest work of nature. Such signs as hunger and taste lead man to nourish his body, and pain and fatigue warn him to avoid dangers.

If he heeds these signs his mind and body will work together as one for seventy years and more. He will be able to resist germs of disease, while no cause of sickness will arise within the body itself. He will go through life with a buoyant sense of strength, eager to do the work which his thoughts are ever planning.

SUMMARY

1. Muscles cover the bones and move the joints.
2. A muscle is a bundle of stringlike cells. When nerves bring it orders to act, it makes itself shorter and pulls its ends together.
3. A muscle usually ends in a long tendon which crosses a joint and is fastened to another bone.
4. Muscles are lean meat. They can be felt in the arms and legs.
5. By use, a muscle grows larger and stronger.
6. By too great use, a muscle is used up faster than the blood builds it again.
7. The power of a muscle comes from the heat of oxidized food.
8. In exercise a muscle needs more food and air, which the stomach, heart, and lungs supply by working harder.
9. Useful and interesting work is the best exercise.
10. Alcohol keeps the stomach from preparing food for the muscles, and takes away their oxygen. Thus it diminishes their strength.
11. Tobacco poisons the muscles.
12. By living as well as we know how, we shall keep the body strong and healthy until old age.

GLOSSARY.

A.

Ab-do'men, the inside of the lower part of the body.

Abscess (*ab'sess*), a collection of creamy matter in the flesh, as a boil.

A-chil'les, an old Greek warrior who could not be harmed excepting in the heel, where he finally received his death wound. Hence the tendon at the heel is named after him.

A-dul'ter-ate, to mix a poor substance with a better one so as to sell the whole for the price of a good article.

Al-bu'min, a substance in the body like the white of an egg. It is found in all living cells and must be supplied with the food.

Al'co-hol, a clear liquid of a burning taste and smell. It is found in all strong drinks and gives them their poisonous qualities.

A-me'ba, a low form of animal consisting of a single microscopic lump of albuminous jelly.

Ap'pe-tite, the desire for food or drink; the desire to satisfy a taste.

Ar'ter-y, a tube which carries blood away from the heart and toward the cells of the body.

Ar-ti-fi'cial res-pir-a'tion, causing air to pass in and out of the lungs of an insensible person.

Au'ri-cle, one of the two thin upper pockets of the heart.

B.

Bac-te'ri-a, the simplest form of living beings. They are plants like tiny balls or rods. They produce decay, and some produce disease in the human body. They are also called *microbes* and *germs*.

Bile, a bitter yellow fluid formed by the liver and poured into the intestine. It is a waste product, but on its way out of the body it assists digestion.

Brain (*brane*), the nervous matter in the skull. By means of it we think, feel, and move.

Bron'chus, one of the wind tubes of the lung.

C.

Cal'lus, a hard and thick spot of epithelium upon the skin. It comes as a result of work, to protect the skin from injury.

Cap'il-la'ry, one of the fine tubes into which arteries pour the blood. They surround each cell and give out blood and air to it.

Car-bon'ic a cid, a gas formed by burning and by oxidation in the body. It is given off in the breath.

Car'ti-lage, a substance which covers the ends of bones within joints. It is often called gristle. It is like bone without lime.

Cell, the smallest part of the body which can live when separated from the rest. The smallest unit of the body. A cell, when cut, dies.

Cer-e-bel'lum, the rounded part of the brain projecting backward from its under side. It assists in performing movements of balancing.

Cer-e'brum, the large upper part of the brain. It feels, thinks, and produces motion in the rest of the body.

Chloral (*klo'ral*), a peppery-tasting, poisonous solid which produces sleep.

Cilia (*sil'i-a*), tiny waving hairs upon the surface of cells. They are found in the epithelial cells lining the air tubes.

Cir-cu-la'tion, the flow of blood through the body.

Clav'i-cle, the collar bone. It extends from the middle of the front of the body to the shoulder.

Co'ca-ine, a substance which benumbs feeling when applied to nerves.

Cold, a sickness caused by exposure to cold and dampness. This injures the cells and permits bacteria of disease to grow upon them and produce disease.

Con-nect'ive tis'sue, the fine fibers which bind the cells of the body in place.

Cook'ing, the preparation of food for eating by the use of heat.

Cor'ne-a, the round, clear window in the front of the eye, which admits light to the inside.

Cor'pus-cle, a cell found in the blood.

D.

De-lir'i-um tre'mens, a mental trouble in which the mind seems to see foul animals and reptiles. It is caused by strong drink.

Der'ma, the true skin. It forms almost the entire thickness of the skin, and contains its nerves and blood tubes.

Di-ges'tion, the process of changing food to a liquid which will pass through the sides of a capillary and into the blood.

Dis-til-la'tion, changing a liquid to steam, and then collecting and cooling the steam until it forms a liquid again. It is used in making alcohol and in obtaining pure water.

Drug, a substance which can affect the body when taken in a small quantity. A medicine.

E.

En-am'el, the hard outer shell of a tooth.

Energy (*en'er-jy*), force which can be used to make a machine work. The energy of the body comes from burning or oxidizing the food.

Ep-i-der'mis, the thin outside part of the skin, which has no feeling. It is composed of cells of epithelium.

Ep-i-the'li-um, the cells which cover the surface of the skin and of mucous membranes, and which line the tubes of all glands.

E-soph'a-gus, the tube down which food is swallowed.

Eustachian (*Yu-sta'ki-an*) **tube**, the tube leading from the middle ear to the throat. It is named after an Italian physician who died in 1574.

Ex-pi-ra'tion, driving air from the lungs.

F.

Faint'ing, losing the senses, with great paleness. It is caused by a sudden weakness of the heart, often due to fright.

Fe'mur, the thigh bone, reaching from the hip to the knee.

Fe'ver, a sickness in which the heat of the body is increased.

Fib'u-la, the bone extending from the knee to the ankle upon the outside of the leg.

Fil'ter, a box filled with sand, charcoal, or other porous substance. It takes impurities out of water which is run through it.

Food, anything which, when taken into the body, can add to its weight, or become oxidized and produce heat and energy.

G.

Gan'gli-on, a collection of nerve cells, especially those in the sympathetic system.

Gas'tric juice, the fluid which the stomach forms to digest food.

Germs, tiny living plants which cause catching diseases. They are also called *bacteria* and *microbes*.

Gland, a collection of tubes made of epithelial cells which produce a substance out of the blood.

H.

Heart, the muscular pump which forces blood through the body.

He-red′i-ty, the influence which is transmitted at birth from parents to children.

Hu′mer-us, the bone of the upper arm, extending from the shoulder to the elbow.

I.

In-flam-ma′tion, heat, swelling, redness, and pain in a part. It is the result of an injury and generally is associated with the growth of disease germs.

The heat, swelling, and redness are due to an increased flow of blood to repair the injury. The pain is due to pressure upon the nerves owing to the increased flow of blood.

In-spi-ra′tion, taking air into the lungs.

In′step, the arch of the foot.

In-tem′per-ance, eating or drinking for mere pleasure, or when the body does not require nourishment.

In-tes′tine, the tube in the lower part of the body, into which food passes from the stomach, and in which it is mainly digested.

In-vol′un-ta-ry mus′cle, a muscle which acts without regard to our knowledge or effort, as the muscle of the heart or stomach.

J.

Joint, the union of two bones, whether flexible or not.

K.

Kid′ney, a red gland which separates urea and other waste matters from the blood.

L.

Lac′te-al, one of the lymphatic tubes which begin in a villus and carry away digested fat.

Larynx (*lar′inks*), the box made of cartilage situated at the beginning of the windpipe. In it the voice is produced.

Lens, a part of the eye, shaped like a small burning glass. It brings light to a point and forms an image of an object upon the back of the eyeball.

Lig'a-ment, the tough bands which bind bones together at joints.

Liv'er, the gland above the stomach which forms the bile and changes digested food to blood.

Lung, a spongy bag from which the red blood cells get air to carry to the cells of the body.

Lymph, the part of the blood which leaves the capillaries to feed the cells.

Lym-phat'ics, the fine tubes which carry lymph back to the blood.

Lymph nodes, small bodies through which lymph flows as through a sponge. These can be felt in the groin and neck. They strain poisons from the lymph.

M.

Malt, barley sprouted and grown until the new shoots are about half an inch in length, and then dried. It is used in making beer.

Mar'row, the fat from the inside of hollow bones.

Me-dul'la, the part of the brain just above the spinal cord. It sends orders for the movements of respiration.

Mem'o-ry, an action of the brain which can be recalled.

Mi'crobes, disease germs. The same as bacteria and germs.

Mi'cro-scope, an arrangement of glasses which make small things seem large to the sight.

Mo'tor nerves, nerves which carry impressions away from the brain, and toward the cells of the body. These impressions cause the cells either to grow, or to move.

Mu'cous mem'brane, the skinlike lining of the inside parts of the body which connect with the air. It lines the passages by which food and air are taken in.

Mu'cus, the thin slimy fluid which mucous membranes produce. It is to the mucous membranes as the sweat is to the true skin.

Mus'cle, a collection of cells whose duty is to produce motion.

N.

Nar-cot'ic, any drug which will benumb pain and produce sleep, as opium.

Nerve, a collection of threads which carry messages between the cells of the spinal cord or brain and the cells of the body.

Ner'vous-ness, a lack of control of the mind over the messages of the nerves. When slight impressions of the nerves cause discomfort, a person is nervous.

Nic'o-tine, a very poisonous liquid found in tobacco. It gives tobacco its taste and smell, and produces its poisonous effects.

Ni'tro-gen, a gas which forms $\frac{4}{5}$ of the air. It has no effect on the body, but its only use is to dilute the oxygen.

O.

O-le-o-mar'ga-rine, an imitation of butter, made of beef fat.

O'pi-um, the juice of the poppy plant. It benumbs pain and produces sleep, and is thus a narcotic. Some men learn to use it as others do tobacco. It is a poison.

Ox-i-da'tion, the union of oxygen with a substance; burning. In breathing, oxygen from the air unites with the cells of the body, slowly burning them, and producing heat.

Ox'y-gen, a gas which forms one fifth of the air. Its uniting with other substances is *burning*.

P.

Pan'cre-as, the gland which forms the pancreatic juice; the sweet-bread.

Pan-cre-at'ic juice, the fluid which the pancreas pours into the intestine. It does most of the work of digestion.

Pa-ral'y-sis, a state of the body in which it is impossible to move or to use some of its parts.

Pel'vis, the heavy ring of bone formed mainly by the hip bones. Its inside contains a part of the intestine.

Per-i-os'te-um, the tough, skinlike membrane covering the bones, and carrying their blood tubes. It produces new bone cells and so causes a bone to grow.

Per-spi-ra'tion, the fluid produced by the skin; the sweat.

Pharynx (*far'inks*), the muscular bag back of the nose and mouth. Through it both food and air pass.

Plas'ma, the liquid part of the blood.

Poi'son, a substance which can harm the body when taken in a small quantity.

Pu'pil, the round opening in the iris or colored part of the eye. It appears black.

Pus, the white, creamy matter in a boil or other abscess.

R.

Ra′di-us, the bone upon the thumb side of the arm, extending from the elbow to the wrist.

Re′flex ac′tion, the act of the spinal cord in sending orders for action in response to information from the cells. It provides for the wants and for the protection of the cells.

S.

Sa-li′va, the fluid always found in the mouth. It moistens the mouth, softens food, and turns starch to sugar.

Scap′u-la, the flat bone behind the shoulder; the shoulder blade.

Sen′ses, the five means by which the mind gets knowledge of the world outside of the body. They are seeing, hearing, feeling, smelling, and tasting.

Sen′so-ry nerve, a nerve which carries impressions from the cells to the spinal cord or to the brain.

Sew′er, an underground tunnel which carries away slops from houses.

Skel′e-ton, the bones of the body.

Skull, the bony structure of the head.

Spi′nal cord, the nervous cord inside the backbone. It gives off nerves, sends reflex orders to the cells, and conducts impulses to and from the brain.

Starch, a food substance found in nearly all kinds of vegetable food. Corn starch and common laundry starch are two kinds.

Stim′u-lant, from a Latin word meaning a whip; a substance which, like a whip, compels the cells to act, but does not furnish them with the power to act.

Stom′ach, the muscular bag into which food enters when it is swallowed.

Su′gar, a sweet vegetable food substance. There are many different forms, but during digestion all become changed to the kind of sugar found in the grape.

Sweat, the fluid produced by the skin; the perspiration.

Sym-pa-thet′ic sys′tem, the collection of nerve cells and nerves which send orders to the muscles of the arteries, stomach, intestine, and heart.

Syn′o′vi-a, a fluid like the white of an egg, which is found inside of joints.

T.

Tar'sal bones, the short bones in the hinder half of the foot.

Tears, the saltish liquid which runs over the eyeball.

Ten'don, a strong cord connecting a muscle with a part to be moved.

Tho-rac'ic duct, a tube like a goose quill, which extends up the front side of the backbone, and carries the lymph to the blood.

Tho'rax, the part of the inside of the body which is covered with ribs.

Tib'i-a, the shin bone, extending from the knee to the ankle.

To-bac'co, a narcotic plant used in smoking and chewing, and as snuff.

U.

Ul'na, the bone extending from the elbow to the wrist upon the little finger side of the arm.

U're-a, the solid waste of the body. It is the ashes of albumin, and is taken from the blood by the kidneys and skin.

V.

Vein (*vane*), a tube carrying blood away from the cells and back toward the heart.

Ven-ti-la'tion, replacing the impure air of a room with pure air.

Ven'tri-cle, one of the thick lower pockets of the heart.

Vil'lus, one of the tiny fingers which project into the intestine from its mucous membrane.

Vo'cal cords, the bands in the larynx, which are set in motion by air to form the voice.

Y.

Yeast, microscopic plants, each made of only a single cell. By their growth they form alcohol and a gas. In making bread, the gas bubbles through the dough and puffs up the loaf until it is light. Yeast cakes are a kind of dried bread dough.

INDEX

S

T

U

V

Eclectic School Readings

A carefully graded collection of fresh, interesting, and instructive supplementary readings for young children. The books are well and copiously illustrated by the best artists, and are handsomely bound in cloth.

Folk-Story Series

Lane's Stories for Children	$0.25
Baldwin's Fairy Stories and Fables	.35
Baldwin's Old Greek Stories	.45

Famous Story Series

Baldwin's Fifty Famous Stories Retold	.35
Baldwin's Old Stories of the East	.45
Defoe's Robinson Crusoe	.50
Clarke's Arabian Nights	.60

Historical Story Series

Eggleston's Stories of Great Americans	.40
Eggleston's Stories of American Life and Adventure	.50
Guerber's Story of the Chosen People	.60
Guerber's Story of the Greeks	.60
Guerber's Story of the Romans	.60
Guerber's Story of the English	
Clarke's Story of Troy	.60
Clarke's Story of Aeneas	.45
Clarke's Story of Caesar	.45

Natural History Series

Kelly's Short Stories of Our Shy Neighbors	.50
Dana's Plants and Their Children	.65

Copies of any of these books will be sent, prepaid, to any address on receipt of the price by the Publishers:

American Book Company

NEW YORK • CINCINNATI • CHICAGO

Zoölogy and Natural History

Burnet's School Zoölogy

By MARGARETTA BURNET. Cloth, 12mo, 216 pages . 75 cents

A new text-book for high schools and academies, by a practical teacher; sufficiently elementary for beginners and full enough for the usual course in Natural History.

Needham's Elementary Lessons in Zoölogy

By JAMES G. NEEDHAM, M.S. Cloth, 12mo, 302 pages . 90 cents

An elementary text-book for high schools, academies, normal schools and preparatory college classes. Special attention is given to the study by scientific methods, laboratory practice, microscopic study and practical zoötomy.

Cooper's Animal Life

By SARAH COOPER. Cloth, 12mo, 427 pages . . . $1.25

An attractive book for young people. Admirably adapted for supplementary readings in Natural History.

Holders' Elementary Zoölogy

By C. F. HOLDER, and J. B. HOLDER, M.D.
Cloth, 12mo, 401 pages $1.20

A text-book for high school classes and other schools of secondary grade.

Hooker's Natural History

By WORTHINGTON HOOKER, M.D. Cloth, 12mo, 394 pages 90 cents

Designed either for the use of schools or for the general reader.

Morse's First Book in Zoölogy

By EDWARD S. MORSE, Ph.D. Boards, 12mo, 204 pages 87 cents

For the first study of animal life. The examples presented are such as are common and familiar.

Nicholson's Text-Book of Zoölogy

By H. A. NICHOLSON, M.D. Cloth, 12mo, 421 pages . $1.38

Revised edition. Adapted for advanced grades of high schools or academies and for first work in college classes.

Steele's Popular Zoölogy

By J. DORMAN STEELE, Ph.D., and J. W. P. JENKS.
Cloth, 12mo, 369 pages $1.20

For academies, preparatory schools and general reading. This popular work is marked by the same clearness of method and simplicity of statement that characterize all Prof. Steele's text-books in the Natural Sciences.

Tenneys' Natural History of Animals

By SANBORN TENNEY and ABBEY A. TENNEY.
Revised Edition. Cloth, 12mo, 281 pages . . . $1.20

This new edition has been entirely reset and thoroughly revised, the recent changes in classification introduced, and the book in all respects brought up to date.

Treat's Home Studies in Nature

By Mrs. MARY TREAT. Cloth, 12mo, 244 pages . . 90 cents

An interesting and instructive addition to the works on Natural History.

Copies of any of the above books will be sent prepaid to any address, on receipt of the price, by the Publishers:

American Book Company

New York • Cincinnati • Chicago

Overton, F.

Applied physiology.

NAME	DATE	NAME	DATE